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PAPERS IN CONNECTION WITH IRRIGATION

IN THE

KARAULI STATE,

WITH

NOTE BY THE CONSULTING ENGINEER FOR IRRIGATION
IN RAJPUTANA



1904.

COMPLIMENTARY

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1904.

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I.

Letter No. 78 K of 4th June 1885, from Mr. C. E. Housden,
Executive Engineer, Karauli, to the Political Agent,
Bharatpur.

No. 78 K.

FROM

C. E. HOUSDEN, Esq.,
EXECUTIVE ENGINEER, KARALI STATE.

TO

THE POLITICAL AGENT,
BHARATPUR.

Dated 4th June 1885.

SIR,—I have the honor to forward herewith my Report on the initiation of Public Works in the Karali State, as detailed on the enclosed sheet.

2. In submitting the Report, I would beg to draw special attention to the following points which the report, I think, brings out:—

- (i) That there is a good deal of land at present lying absolutely waste, which can be brought under cultivation and yield a fair revenue, if by low rates, good government, and the construction of the necessary wells and tanks, settlers can be attracted and induced to take up the land.
- (ii.) That of the area at present under cultivation, a very small percentage only is worked during the "Rabi," and that if in consequence water can only be supplied to land at present only cultivated during the "Kharif," the value of the land can be increased fourfold, that is, a revenue of Rs. 4 per bigah realized in place of one rupee.
- (iii.) That water can be supplied in most places either by the construction of tanks, for which sites have been noted; by the construction of wells in suitable localities, also noted; and by the utilization of the perennial streams of which there are several in the State.

No project for the last named method of providing for irrigation has been put forward in this Report, as I have not as yet been able to collect the necessary data. I am now, however, prospecting for, and hope to be able to work out a line for a canal from the Amargarh Nadi, near Raontia, to the extensive tract of culturable land about Sairota. The dam or weir under contemplation at Dargosi might also come under this head.

- (iv.) That putting aside for the present all consideration of the indirect benefit to the State, and above all the cultivators and ryot, which must result from a development of the country, and which it is impossible adequately to measure, a *direct* return of from Rs. 3 to 30 per cent. may be anticipated on any moneys spent on "Productive Works."

- (v.) That to allow of the contemplated improvements being systematically carried out under skilled supervision, it is necessary that a permanent Public Works Establishment be entertained and placed on a satisfactory footing.
 - (vi.) That in the interests of all concerned, a Revenue Survey of the State is desirable.
 - (vii.) That as a rule most of the proposed improvements be carried out from the funds at the disposal of the State and not from borrowed capital; but that any large works from which a direct return of over 15 per cent. per annum can be expected, and the construction of which owing to the cost of the same cannot be conveniently arranged for, from the annual allotments for Public Works, be constructed from borrowed capital.
3. I would also beg to direct attention to—
- (a) Appendix E, where the results of the examination of Tanks, &c., are abstracted in a handy and convenient form.
 - (b) The Topographical Survey Sheets, where will be found noted the greater part of the information scattered about in the several parts of the Report and Appendices.
4. In conclusion, I venture to hope that the Report will meet with your approval.

I have, &c.,

C. E. HOUSDEN,
Executive Engineer.

II.

REPORT

ON

PUBLIC WORKS IN THE KARAULI STATE.

REPORT ON PUBLIC WORKS, KARAULI STATE.

1. From the instructions I received and from what I have gathered from subsequent conversations, I understand that the main object in view in obtaining my deputation was to secure as full a general report as possible on the resources of the State, with reference to the construction of Public Works likely to pay and increase the revenue, and also materially benefit the population, at as low a cost as possible: With this object in view, I have visited almost every part of this State, and made out rough plans and estimates for the various improvements asked for by the villagers, or which have suggested themselves to me.

Objects with which the Report has been framed.

I have noted the character of the soil, the depth with which water is met with in wells at present in existence, the perennial streams, the chief lines of communications, and other useful data. Most of this information is given on the Topographical Survey Sheets submitted herewith, and is also briefly noticed in this Report, and given in detail in the Appendices attached thereto.

2. I arrived at Karauli on the 15th of January 1885. In accordance with my instructions I first devoted my attention to getting out a line for the road from Hindaun to Karauli and other emergent works. This took some time, and it was not till March that I was quite at liberty to devote the greater part of my attention to the preparation of this Report. Owing to this delay I have not been able to explore the State quite so thoroughly as I should have liked to do. I have, I am glad to say, been able to visit and examine the greater portion, and have collected sufficient information to show, as I trust will be made clear further on, that the State must benefit and to a considerable extent, by money judiciously spent, and that in the culturable portions of the State there exists a large field for development by the construction of paying Public Improvements.

Date of arrival and commencement of work.

3. Before going into the details of the information collected, it would, I think, be advisable to take a general view of the geographical and physical features of the State.

Short description of the Karauli State, chiefly with reference to its Geographical and Physical features.

Karauli lies buried in between the Rajputana States of Jaipur, Bharatpur, and Dholpur, and the Central India State of Gwalior. It is bounded on the west and south by Jaipur, on the north by Bharatpur and Dholpur, and on the east the Chambal separates it from Gwalior. Owing partly to this fact and partly to the difficulty of communication due to the broken nature of the ground on its borders, it is singularly isolated and behind the times.

The trade is small and the mass of the inhabitants poor. The following are the main characteristics of its physical features. The whole State may be roughly said to be divided into a number of ridges (running from N.-E. to S.-W.), and consisting of a series of parallel ranges of low hills, with small and narrow valleys in between them.

The most extensive and widest range of hills is the one on the east next to the Chambal, and known locally as the Dang; its width varies from 12 miles to $1\frac{1}{2}$ miles. This Dang forms one of the main features of the State (indeed more than $\frac{1}{3}$ of the area of the State is covered by it), and consists of a raised and well-defined main plateau, the top of which is again broken up into a series of small hills, low and round-topped, often so flat as to be nearly level. On the top of such hills, and in the valleys in between them, patches of culturable soil are here and there met with. The general characteristics are, however, existence of rock, consequent want of soil and water, and as a result a barren and unprofitable soil. Where culturable soil exists and is washed during the rains by flood water, rice is grown to a considerable extent. The fields are in terraces, formed by small bunds known locally as "pokers," and the flood waters flow from one to the other in succession. The drainage of the Dang is chiefly to the west, and from it flow the chief perennial streams in the State. These streams debouch into what may be called the main Karauli valley, and find their way from it either by breaking through the opposite range of hills, as near the town of Karauli, where the Panchua forces its way through a narrow gorge, or by flowing to the south along the main valley, as in the case with the Amargarh Naddi. In the main valley, and in fact in most of the valleys, a very different soil to that met with in the Dang prevails.

The valley soil generally consists of from 10 to 30 feet of loose sandy soil overlying a bed of stiff clay, mixed with a considerable amount of kankar. The top soil is extremely fertile if water can be supplied it; owing, however, to its excessively loose composition and to the velocity with which the nallahs and watercourses from the neighbouring hills descend, it soon cuts away, and extensive nallahs and ravines, ranging from 10 to 60 feet deep, are thus formed. One effect of the lowering of the nallah beds is to completely drain the country of water and to lower the level of sub-soil drainage to such a considerable extent as to entirely, in parts, prohibit even cultivation, the depth of the wells being in some cases (as at the Residency) over 100 feet. Another effect of the nallahs thus formed is to increase the difficulty of the communications; owing to the excessive inequalities there are very few parts of the country where carts can ply.

A third effect is, that owing to the tendency which the ravines thus formed have to increase, they yearly encroach on good culturable soil bordering on them, and so, year by year, gradually reduce the area of good land.

The principal perennial streams are the Barkheri, the Bhadrauti and their branches to the same forming the Panchua; the Amargarh Naddi and its branches, and the Ogha. The Dang, and in fact all the hills in the State except those lying to the extreme west near Dahra, consist of red sand-stone. This stone is easily quarried and easily worked.

The hills are everywhere, except on the top of the Dang or where the jungle is much cut down, covered with thickets of stunted Dhow, with here and there in the hollows a few dhak trees. The list of indigenous trees is completed by a few Babool, Neem, Sheeslum, Mhowa, Peepal, Bar, and Karil trees, met with here and there singly or in small clumps.

The main point I wish, however, to establish is, that the hills are, as a rule, bare and devoid of anything like Forest. Of jungle there is a good deal, and this consists in the main of dwarf black Dhow.

4. Having thus briefly gone over the general features of the State as a whole, I proceed to pass in review the local characteristics of its various divisions. It has appeared to me that the best way in which these could be examined was to note them on the Topographical Survey Sheets, and then taking up each sheet separately to draw attention to the points needing notice.

Detailed
Notice of
local
character-
istics.

Sheet No. 8

Commencing these from the north and with Sheet No. 8, we see that only a small and wild and broken part of the State has here to be treated. The only extensive culturable portions are the patches of land about Dahra, and Saumora, and along the banks of the nullah flowing past this place.

Well cultivation is carried on here and there, the average depth of wells being 45 feet.

Depth to water	...	...	...	28½ feet.
Depth of water	...	...	...	14 „

There are no tanks at present in working order.

There are the remains of two old tanks about Dahra. One of these it is proposed to repair. The estimated cost is Rs. 7,042 (See Appendix D, Part I.)

New tanks marked Nos. 2, 3, 4 and 5 respectively are also estimated for. When owing to the construction of these tanks the level of the water in the wells about Dahra has been raised, portions which can not be irrigated from the tanks and are at present lying barren, or only cultivated during the Kharif, can be brought under cultivation by the construction of wells, for the probable cost and expected return of which see notes on wells, para. 6 of this Report.

Sheet No. 8½.

About half the area shown in this sheet consists of broken ground. The remainder is good culturable soil cut up, however, here and there by ravines. There is, nevertheless, a large field for improvement. This will be seen from the fact that 24 sites for new tanks have been selected and reported on, and that nowhere is the water in the existing wells at any considerable depth below the surface. For detailed reports on the tanks, see Appendix A. There are numbers of old wells which want cleaning out and repairing, and 4 * old tanks need repair—in short renewal. There is every sign to show that the country was once cultivated to a far greater extent than at present. The tanks at present in existence and use are :—

Meola (needs repair.)

Chamoraola.

Bhojpur.

A number of small tanks about Machilpur and Bhaoli.

A few small tanks in the Dang.

The existing wells are numerous.

The best project in this sheet is for a tank at Soohara. This is estimated to cost Rs. 16,271, to hold 60 m. c.ft. of water, and to irrigate 625 bighas, and yield an ultimate revenue of Rs. 1,875. The project for a tank at Roondkapura is also a good one.

The main thoroughfare to Agra from Karauli via Machilpur lies mainly in this sheet.

Sheet No. 10 (a).

The area of the State embraced in this sheet consists almost entirely of low rounded rocky hills locally known as the "Dang," and already referred to in para. 3 of this Report. The only extensive tracts of culturable land are those near Karauli and Mandral. In the Dang itself, here and there small patches of good ground are met with, and as the contour of the ground is favourable for the construction of tanks, something can also be made of them.

Seventeen sites for tanks have been examined and reported on; there are doubtless many others equally as good in parts not visited. The main project in this sheet is for a large tank at Nindar. The estimated cost of the entire project is Rs. 44,347, and the estimated increase to the revenue Rs. 10,000 or 22 per cent.

A large but expensive tank can also be made at Dorgosi on the Barkheri.

* Tank at Kasara No. 10, tank at Anajara No. 6, tank at Malpur Ngraina No. 7, tank to E. of Machilpur No. 9.

The descents from the Dang to the valley of the Chambal are steep, and all the ghauts (of which there are six) want to be improved; the best one is the one up from Makakoa to Nankhoor.

The perennial streams are the Badhraoti and the Barkheri, with the branches.

Sheet No. 10 (b).

The tract of country in the Karauli State embraced in this sheet is a small portion of the valley of the Chambal. The chief feature to be noticed is, that south of Rudai the level of sub-soil water is very near to the surface, and that consequently wells can be cheaply and easily sunk. There is also a good deal of good ground (chiefly along the banks of the streams) at present lying idle. I have made enquiries to ascertain why this should be so, and have been told that the inhabitants are not agriculturists. They, almost to a man, depend for their livelihood on their flocks and herds. It will thus be seen that there is a good deal of land capable of easy development, if cultivators can be, by easy terms and good government, induced to settle. There are also some good sites for tanks (six in all have been examined and reported on); of these the best is at Arora. For further details see Appendix A.

Sheet No. 39.

The portion of the Karauli State shown in this sheet is a good and fertile one, already developed to a considerable extent. Besides a few wells and small bunds nothing further appears necessary.

Sheet No. 42.

In this sheet are contained the best and most fertile tracts in the Karauli State, and at least 75 per cent. of the area is fit for cultivation. The greater part of this is, as a matter of fact, also cultivated during the Kharif.

Owing to want of water and general apathy, the Rabi cultivation is however small, large tracts lying idle during the winter months. The area of the portion of the State now under notice is roughly $\frac{1}{2} \times 36 \times 15 = 207$, sq. miles. If we assume that 150 sq. miles of this is good land fit for cultivation, we have an area of 3,00,000 of bighas to work on; half this area is land belonging to Thakurs, Temples, &c., leaving about 1,50,000 bighas of State land, which, if fully developed and yielding a return of 3 rupees per Bigha, would give the State a revenue of Rs. 4,50,000, or more than the present revenue of the entire State.

These figures are mere approximations, however, and are here given with a view to show what a large field there is to work on, and also to show how necessary it is that a careful Revenue Survey of the entire State should be made, and the exact area of culturable land determined and properly assessed. Sites for 19 tanks have been examined and reported on. The best is the project for a large tank at Gotra (No. 2, Appendix A.)

This is estimated to cost Rs. 73,924 and to irrigate 5,000 bighas, yielding a probable Revenue of Rs. 15,000.

The construction of wells in the parts noted on the plan would also pay well. (See Notes on wells).

Sheet No. 43.

The area of the State embraced in this sheet chiefly consists of hills forming the Dang or highland.

As before remarked the general character of the country is not favourable to the development of revenue, the patches of culturable land being few and small. Attention should be confined to developing the present system of "*pokhers*," by which are formed terraced fields in which rice is grown; and here and there constructing a tank sufficiently large to retain water all the year round. The object of these large tanks is to provide drinking water. At present during the summer months many of the hamlets are altogether deserted, the inhabitants seeking refuge in Gwalior, from where they are often not disposed to return. Large tanks which retained water all the year would attract people and induce them to settle, and the regular cultivation of all the rice fields in the immediate neighbourhood be thus secured.

The tank recently constructed at Naini Goari is an example of what I now recommend. By carefully choosing the site any dam constructed should be able to pay a direct return of 4 or 5 per cent. The indirect gain would be much greater. The tank sites examined and reported on are eight in number. Of these the Naini Goari Tank has just been constructed, and the Maidpura and Kalianpur Tanks are old ones needing repair. Of the remainder the Kanarda Tank (No. 5, Appendix A) will probably be the best and most paying one. This, however, is not on the Dang.

TANKS.

5. The tanks at present in existence and use in the State are few in number, as will be seen from a reference to the Survey Sheet and the list given in Appendix B.

Those in existence may roughly be divided into two classes :—

- (i.) The "*Talab*," in which after the tank has once filled, the water is drained off, and the bed cultivated.
- (ii.) The "*Sagar*," in which water is stored for subsequent use.

The Dowlatpur-Kalianpur Tank, the Dabra Tank, and the ones in the west corner of Hazru Tehsil are instances of the former. The tank at Bhojpur, the Madna Sagar, the new tank at Naini Goari, and almost all the small tanks in the Dang are instances of the latter; and as a rule, it may be safely assumed that the former are applicable to places where the soil is excessively sandy, and where, owing to the excessive loss by percolation, it would be next to impossible to store water; and the latter to the Dang and other places where water can be stored.

It can easily be shown that the sagar is the more paying one of the two. To irrigate a bigha of land, about 60,000 cubic feet of water are required. This gives an average depth of $\frac{60,000}{14,400} = 4\frac{1}{2}$ of water for each bigha. That is, if the average depth of water stored in a tank is $4\frac{1}{2}$ feet, the water so stored will irrigate as much land below the tank bund as is included in the bed area of the tank. As, however, even in the smallest tanks (sagar) the average depth will, if the site is well chosen, be more than twice $4\frac{1}{2}$ feet, the area below the tank bund which can be irrigated therefrom will, as a rule, be more than twice the bed area of the tank.

Or, to put the same thing in another way :—

As long as the average depth of water in a tank exceeds $4\frac{1}{2}$ feet, more land can be cultivated below the tank bund, than in the bed. Whereas when it falls below $4\frac{1}{2}$ feet the area in the bed will be the larger of the two. From this we gather that in constructing tanks of the first sort (the talab) we ought to try and secure as large a bed area as possible. The tank formed should be a large and shallow one—a narrow gorge with the ground sloping gently to it from all sides is the most favourable site for such a tank. For the *sagar*, on the contrary, the object to be kept in view is to store as much water as possible, and the tank will, as a rule, have to be a deep one with, at the same time, as large a bed area as can be obtained.

Projects for both kinds of tanks are included in the list of new tanks submitted with this Report. The most paying ones, the tanks at Gotra and Nindar, are both examples of the second class (the sagar).

The proposed tanks at Kanarda and Arora are, on the contrary, also good specimens of the 1st class, as is also the tank at Amargarh now under construction, and the Dowlatpur Tank already in existence.

It will be seen from Appendix E that 81 sites for tanks have been examined and reported on. The estimated cost of these tanks varies from Rs. 1,150 to Rs. 75,000, and the estimated profits from Rs. 100 to Rs. 1,500, depending of course a good deal on the configuration of the ground, bed, area, area commanded, &c.

The estimated cost has been designedly fixed at a high figure to guard against underestimating, and I see no reason why most of the tanks should not be built for 20 per cent. less than the figures quoted. On the other hand the estimated return has been kept somewhat under

what the ultimate return should be. This ultimate return can, however, except in a few exceptional cases, not be counted on for the first few years during which the land will be under preparation.

I would also again draw attention to the fact that the estimates now submitted, excepting those for which projects have been worked out in detail, though I believe fairly accurate, are not to be implicitly depended on. Each project should, when finally taken up, be reconsidered afresh in all its bearings, and proper designs and estimates drawn out. The reports now sent in will, however, I trust, serve as valuable guides in determining the order in which the several projects should be taken in hand, and as checks on the complete estimates when framed. The amount of these should always be below the figures now given. It will, perhaps, be considered that the average cost of the dams is too high. This, I would point out, is due to two reasons :—

- (i) The depth of the nallahs to be bunded, and
- (ii) The configuration of the ground in the vicinity of the nallahs, as a rule, and due chiefly to the narrowness of the valleys, the slope from either side towards the nallahs, is excessive, and it is very seldom that without making a good high bund a sufficiently large bed area can, in consequence, be secured.

To take a typical instance of a tank already constructed :—

On examination of the Plans of the Dabra Tank, which a glance at the map will show is situated in about the widest valley in the Karauli State, it will be seen that by the construction of a bund 300 r. ft. in length and 40 ft. in height at its greatest, a wineglass-shaped bed, only containing an area of 7,500,000 sq. ft. or 521 bighas, has been formed.

Too much care cannot, therefore, be taken in selecting the sites for tanks and in making a thorough examination and surveys of the neighbourhood to place beyond doubt :—

- (i) The bed area of proposed tank.
- (ii) The contents " " "
- (iii) The area commanded, and
- (iv) The return to be anticipated.

These facts having been ascertained, next comes the question of the section to be adopted, and though I have in the estimates made out by me and submitted with this Report, always selected a section with a core-wall, this will not always be necessary, though as a rule it is desirable to have one. It will be better, therefore, in the first instance in most cases to construct a simple earthen bund with masonry sluices and a masonry weir. Should this stand, nothing further is required, and a good deal of money will have been saved ; if it is breached, a core-wall at the breach will probably be necessary, and can then be supplied. In places a core-wall will, of course, be necessary from the first. I have in the detailed notes on the projects submitted, generally noted when this is the case (see Appendix A).

The point I wish, however, to bring out is, that as a rule the cheapest section, an earthen bund, should be first of all adopted; and when this does not prove strong enough, a core-wall can be added. An ample masonry weir and a masonry sluice should always be provided.

WELLS.

6. Type Section of four sizes of wells are submitted with this report, viz:—

7 ft.	diameter	or one	charas well.
10 ft.	„	or two	„
12 ft.	„	or three	„
14 ft.	„	or four	„

(See Appendix C.)

The first size is calculated to be capable of irrigating from 8 to 15 bighas, according to the depth of water below ground level.

The second size from 12 bighas to 20 bighas.

The third size „ 15 „ to 25 „

The fourth size „ 20 „ to 30 „

These figures have been arrived at from enquiries made, and from an examination of wells in existence.

The maximum cost of a well of the 1st size should for 60 ft. depth				
not be more than	...	...	...	Rs. 600
of the 2nd size	...	...	...	„ 800
„ 3rd „	...	...	...	„ 1,000
„ 4th „	...	..	..	„ 1,500

(See Estimates for details).

And the revenue derived from the land irrigated should be for an expenditure of—

600 Rs.	from 40 to 75 or $6\frac{2}{3}$ p. c.	to $12\frac{3}{4}$ p. c.
800 Rs.	„ 60 to 100 or $7\frac{1}{2}$ = to 15 p. c.	
1,000 Rs.	„ 75 to 120 or $7\frac{1}{2}$ = to $12\frac{1}{2}$ p. c.	
1,500 Rs.	„ 100 to 150 or $6\frac{2}{3}$ = to 10 p. c.	

These figures show how well, wells, even when it is found necessary to make them 60 ft. deep, may be expected to pay. As a rule in most of the areas shown on the Survey Sheets as fit for well sinking, it will not be necessary to sink the well shafts more than 40 feet, and in some places, as at Karanpur, not more than from 20 to 30 feet. I would therefore advise the expenditure of a good proportion of the money available on new wells.

The construction of wells is also more suited to the limited resources at the disposal of the State. Costing, as a rule, about Rs. 500 each on the average they can be constructed as funds admit.

There are numbers of old wells in the State which have fallen in or which simply want deepening, and can be put into good working order at costs varying from Rs. 50 to 200. I would recommend that all repairs to old wells and the construction of new ones be carried out by the villagers themselves, under the joint supervision of the Tehsildars and the Public Works Overseer. The villagers are quite capable of sinking their own wells, and it is better that any small profit made on the sanctioned amount should go to them than into the pockets of an outsider.

Estimates
how
framed.

7. The question of estimates has been a difficult one to deal with. It was obviously impossible with the establishment at my disposal, and in the short space of time that I could devote to the work, to draw out full projects and reports on the 81 tank schemes considered. I had therefore to content myself with an accurate approximation. With this object in view, a number of type sections of different designs were prepared, and the quantities taken out for every 5 ft. in height and for a length of 100 r.ft. These type sections are all given in the accompanying Appendix E.

The assumed rates are :—

Masonry in lime	...	...	Rs. 20 per cent. c.ft.
Earthwork	...	...	" 4 " "
Face or core-wall of slabs	...	...	" 30 " s.ft.
Puddling	...	...	" 2 " c.ft.
Concrete...	..	...	" 10 " "

somewhat higher than those ruling in the State.

The relative costs of the several sections considered has also been worked out for every 5 ft. in height, and it has thus been possible to quickly and accurately get at the approximate cost of a bund, once the cross section of the site was determined; and the figures now quoted for the probable cost of a dam may be taken as fairly representing the cost and being if anything over the mark.

Types E and L are the ones recommended for general adoption, and the ones which have been chiefly used in framing the estimates. In the same way type sections of the different sizes of wells recommended have also been made out, and a comparative statement of the cost for every 10 ft. of depth prepared.

Data on
which cal-
culation
for Tanks,
&c., have
been based.

8. The results quoted in various parts of this Report have been arrived at from the following data :—

TANKS.

(a) *Run off*.—The average rainfall at Karauli has, during the last 5 years, been 28·37 inches, and has ranged from 29·73 to 40 inches.

To be on the safe side the average assumed has been 27 inches, and the probable run off has been taken at $\frac{1}{3}$ rd of this or 9 inches. This gives

for each mile of catchment area a discharge of $\frac{3}{4} \times 27,878,400 = 20,908,800$ c.ft. or say 21 m. c.ft., which has been taken as the probable run off from each sq. mile of catchment area. On the "Dang" or rocky portion it is probably greater than this.

(b) *Area irrigable from water stored.*—For each bigha of land irrigated from a proposed tank, it has been assumed that 80,000 c.ft. of water is required. This is inclusive of probable loss by evaporation and percolation, and is equivalent to 2,400,000 c.ft. per acre. The average storage required for an acre in Ajmer-Merwara is, according to Lieut. Homes' Report No. 139, dated Mussoorie 3rd August 1868, 1,77,261 c.ft. per acre; or say roughly about 60,000 c.ft. per bigha or $\frac{3}{4}$ of the assumed quantity.

(c) *Catchment Area.*—This has been invariably taken from the Topographical Survey Sheets. Scale 1 mile = 1 inch. It can there be quickly and accurately arrived at.

(d) *Bed area and Area commanded.*—This has been taken out from measurements and surveys. In some instances taken out in detail and in others only approximately.

(e) *Estimates, Designs for Tanks, &c.*—These are based on the details of quantities and Type Sections, which accompany this Report (see Appendix C.)

WELLS.

(a) *Cost.*—This is arrived at as detailed in the estimates given in Appendix C.

(b) *Area Irrigable.*—The figures given in para. 6 have been arrived at partly from enquiries made in different localities and different individuals, and partly from a consideration of the area irrigated by wells examined and measured.

(c) *Anticipated increase to Revenue.*—This has been arrived at from consultations with the local villagers, and when they could or would not give definite information, or make any promises to take up land at fixed rates, from a consideration of the average rates derived at present from tracts under "Barani" and "Chahi" cultivation. These vary considerably. Roughly speaking, however, the revenue derived from Barani land ranges from Rs. 1 to 2 per bigha, that from Chahi, from Rs. 2 to 5; good land in parts being even assessed at from Rs. 6 to 12; this however is exceptional.

9. *Revenue Survey recommended.*—I would strongly recommend a Revenue Survey of the State. At present the areas of culturable land in the villages belonging to the State are but roughly known, and the boundaries between the Khalsa and Jagir villages of the vaguest. Again the rates at which the same kind of land are assessed vary considerably in several parts of the State; in some cases the State suffers, in others the villagers are called upon to pay a revenue they cannot possibly meet, and the temptation to go over into the neighbouring States is irresistible.

Revenue
Survey
required.

I am confident that the State would be considerably benefitted by the Survey proposed. Even if any direct benefit did not accrue therefrom, there would be the satisfaction of knowing with certainty the area of culturable soil and the revenue derived therefrom, and of, as far as possible, equalizing the tax on the cultivator.

Old tanks, wells, &c., would then also be brought to light, and the Survey would be an invaluable guide to the selection of suitable sites for new tanks and wells.

The Khalsa villages could be surveyed and the surveys plotted on a scale of 16 inches to a mile for about Rs. 3,600.

10. Recommendations Having thus briefly taken a general survey of the requirements of the State, and having explained how far the reports, estimates, and tables of statistics submitted with this Report are to be relied upon, I come to the most important part of my Report, *viz.*, a consideration of how the information thus collected can be best turned to the advantage of the State. There is no doubt that there is a large field for improvement.

The question now to be considered is, how, with the limited funds at the disposal of the State, can any of the contemplated improvements best be carried out.

A consideration of the projects submitted will show that they may roughly be divided into four classes:—

- (i.) Projects for large new tanks costing over Rs. 20,000, and which are expected to pay over 15 per cent. on the contemplated expenditure.
- (ii.) Projects for smaller new tanks, costing generally under Rs. 20,000, and expected to pay less than 15 per cent. on the contemplated expenditure. Also projects for the construction of new wells, which are expected to pay from 10 to 30 per cent.
- (iii.) Projects for repairs and renewals to existing tanks and wells.
- (iv.) Projects for improvements to communications.

The projects included in *Class 4* are few in number (six in all as noted in the margin). I would recommend that these projects be carried out at once and on borrowed capital, and for the following reasons:—

Tank at Gotra ...	Rs. 75,000
" " Nindar ...	45,000
" " Arora ...	30,000
" " Kanarda ...	23,300
" " Sahora ...	16,300
" " Roondkapura ...	27,500
Total ...	2,17,100

- (i.) Because it is desirable that when a project is taken in hand it should be finished off as soon as possible to prevent unnecessary "dragging" in the execution of the work, which leads to general slackness, and tends to raise the cost and deteriorate the quality of work turned out. The funds at the dis-

posal of the State being limited to about Rs. 50,000 per annum, out of which, as I shall show later on, some Rs. 30,000 are required for other public works, there remain only 20,000 for allotment to new tanks, and if a large project costing say Rs. 60,000 is carried out from this money, it will take three years in completion, and altogether prevent smaller, and may be, emergent works from being taken up at all during this time ; and,

- (ii) because the anticipated return on the expenditure proposed is sufficient not only to pay for the interest on money borrowed, but also to pay a handsome return on the money expended and thus to justify the use of borrowed capital in the construction of these works.

The projects included in Classes ii, iii and iv are not anticipated to pay sufficiently well to justify their construction from borrowed funds, and it is from such works as these that the greater part of the funds available should, if spent with due care and forethought, realize a handsome percentage. Assuming therefore that the projects included in Class (i) will be carried out from borrowed funds—

- (i) Briefly then, I would recommend that Rs. 2,00,000 be borrowed at once, and the following projects for which detailed estimates are submitted be taken up and carried out at once from the money so raised. Tanks at—

Nindar.

Gotra.

Sohara.

Roondkapura.

- (ii.) That the services of an Executive Engineer be retained for a year or two to allow of these large works being constructed under the supervision of a responsible officer. In addition to supervising these works, he would be able to inaugurate, and, before leaving, to a certain extent perfect the system on which work should in future be carried on. The establishment to be permanently retained would have the benefit of two years' training to the duties expected of them before being left to their own resources, and above all the working rates for the different localities of the State could be placed on a satisfactory basis. He could also, if required, supervise a revenue survey of the entire State. This is much wanted, as already stated.
- (iii.) That other projects, for which only rough estimates are now submitted, be from time to time carefully prepared and carried out as funds permit. That as a rule, out of the yearly allowance of Rs. 50,000, some 30,000 be devoted to reproductive Public Works, and the remaining 20,000 to unproductive works and to repairs of existing tanks, wells, buildings and roads.

- (iv.) That on the average two new tanks, from 20 to 30 new wells and two miles of metalled road or 10 miles of fair weather road be annually constructed.

Materials.—With the exception of good timber and iron, all materials ordinarily required for construction can be procured in most parts of the State with ease and facility, thus:—

Stone.—Good building stone can be had almost anywhere within reasonable distance. The stone quarries at Karauli itself are celebrated for the good sandstone turned out from them. This stone can be worked and carved most easily, and for building purposes is as good an article as can be desired.

Kankar.—For road metalling. Though this does not occur anywhere in sufficient quantities to allow of regular quarries being opened, it is to be met with in sufficient quantities in the banks of all the nallahs to meet all demands.

Kankar for Lime.—The beds of all the nallahs are covered with kankar nodules, which, though not suitable for use in metalling roads, are admirably adapted for making lime from, the fact that the nodules are worn smooth not interfering with their being successfully burnt for lime. Good limestone is also to be found in one or two spots

Wood for lime burning can be procured in most parts of the State.

Working rates.—The working rates ruling in the State, and for which work has been up to date done, and is now being done, are given below. They appear to be fair ones. Further acquaintance with the district and the construction of one or two large works by daily labour under strict supervision, will probably allow of these being reduced somewhat.

Stone-masonry in lime.—From Rs. 15 to Rs. 20 per 100 c.ft.

Slab-masonry in lime.—The walls being from 1 to 2 feet thick, and filled in between slabs with dry stone.—From Rs. 25 to 30 per 100 sq. ft.

Masonry dry stone.—From Rs. 7 to 10 per 100 c.ft.

Concrete in Foundations.—From Rs. 8 to 10 per 100 c.ft.

Stone Pitching.—From Rs. 3 to 5 per 100 s.ft.

Earthwork.—From Rs. 2 to 7 per 1,000 c.ft.

Kankar Collections.—From Rs. $\frac{3}{8}$ to $\frac{4}{8}$ per 100 c.ft.

Kankar Consolidation.—From Rs. $\frac{1}{8}$ to 2 per 100 c.ft.

C. E. HOUSDEN,

Karauli, 4th June 1884.

Executive Engineer.

III.

APPENDIX A.

DETAILED REPORT ON TANKS SELECTED.

DETAILED REPORT ON TANKS SELECTED.

Topographical Survey—Sheet No. 8.

No. 1.—Tank at Darha.—The tank which it is proposed to repair here has, according to the villagers, not been in use since Madan Pal's time. The estimated cost is Rs. 7,000.

There are 300 bighas of good land below the bund, of which I assume that 200 can be brought under cultivation. As the water in the bed of the tank will spread over a large area, a portion can be drained off shortly after the rains, and another 100 bighas in the bed thus cultivated. The catchment area is about $2\frac{1}{2}$ sq. miles, and the tank ought to fill well.

No. 2.—Opposite Ghuzzeepur.—The nullah which drains the Darha Valley is gradually cutting away its bed, and the branch nullahs in the valley thus yearly increase in size and depth.

The site selected for the bund is a good one. The nullah has here worn a narrow channel through a bed of shaley rock.

Though the main object of the dam proposed for this place is to prevent the nullahs in the Darha Valley from increasing, the construction of the tank will also bring 200 bighas of land under cultivation, and a small return for the money thus expended will be realized. The estimated cost of the dam is Rs. 3,800. (See Appendix D, No. 1).

No. 3.—I came across this site when on my way from Darha to Bhojpur over the Dang. I had no instruments with me, and I have not been able to subsequently visit the site.

I can, however, state with confidence that for about Rs. 8,000 a tank sufficiently large to irrigate 300 bighas in the Darha Valley down below can be built.

The land which would thus be brought under cultivation cannot be irrigated from either of the tanks above noticed, nor can wells be sunk on it, as it is near the foot of the Dang, and consequently at a high level. (See Appendix D, No. 2).

Nos. 4, 5, 6.—These bunds the villagers of Pepal Khara and Gojurpur are anxious to get constructed, chiefly with the object of preventing the nullahs from increasing and cutting away existing fields and wells. They say they cannot promise to make any increase to the revenue, as the assessment is already a high one.

It is probable, however, that there will be an increase, and even if this is not the case the present revenue will be maintained, and good land preserved.

Wells.—Wells can, in this sheet, be sunk with advantage about Darha and Jammora. The land, however, in the last-mentioned village is all under cultivation, and Rs. 4-5-0 per bigha paid for it, and nothing further need for the present be thought of.

About Darha, however, when the two tanks (Nos. 1 and 2) are made and the water level in the valley raised, every patch of culturable ground should be brought under well or tank cultivation. This should be in time a rich valley.

Topographical Survey—Sheet No. 8½.

No. 1.—*Tank at Meola.*—Already in use, wants deepening. The villagers are ready to carry out the necessary repairs if a taccavi advance is made to them.

Site No. 2.—*Tank at Chamraole.*—One of the few with water in them now (February 4th '85). It would be the better for a little deepening. This is estimated to cost about Rs. 200.

No. 3.—*Tank at Bhojpur.*—This is without doubt the best tank at present in existence and use in Kurauli. It is formed by an earthen and drystone bund, which has been thrown across a narrow gap in the range of hills to the east of Jewungarh Fort. The tank lies immediately below the fort, and has a bed area of about 3,000,000 sq. ft., with an average depth of 10 ft. The cubical contents would be $3,000,000 \times 10 = 30 \text{ m.c.ft.}$, or sufficient to irrigate about 500 bighas.

There is at present no sluice from the tank, the bund leaks badly, and all the water that finds its way through is gathered into a couple of small ducts and utilized. There is a good deal of fallow land below the dam which could be brought into use if a sluice were made in the tank and proper ducts led therefrom. Assuming the sluice and ducts to cost Rs. 2,000, and that 200 bighas of land, yielding a revenue of Rs. 3 per bigha are thus brought under cultivation, a return of Rs. 30 per cent. is thus ensured. Detailed surveys can alone show how far the water stored in the tank can best be utilized. At present it is more or less wasted.

This is a project that should be early taken up and worked out. I regret that want of time has prevented me from working it out in detail.

I am convinced, however, that a good deal can be done in the way of making the tank pay more than it does. (See Appendix D, No. 3).

No. 4.—*Tank near Bhojpur.*—The tank proposed here would command and irrigate land which cannot possibly be irrigated from No. 3. The estimated cost is Rs. 7,400.

The land commanded below the tank is estimated at 200 bighas, and assuming a return of Rs. 3 per bigha, an increase to the revenue of Rs. 600 per annum is expected. All the land commanded is at present lying idle. The tank is desired by the villagers.

No. 5.—For a Tank at Madanpur.—This is desired by the villagers. It is chiefly intended to bring a lot of broken and waste ground into use by enclosing it in the bed of the tank, and cultivating it after a year or two, when the inequalities have been levelled off.

The culturable area in the bed is estimated at 300 bighas. If the tank holds water another 200 bighas can be brought under cultivation below the tanks. The anticipated increase to the revenue is Rs. 1,000, the estimated cost Rs. 17,600.

No. 6.—Repairs to an old Tank Bund at Anajara.—This is much desired by the villagers, as the first bund has silted up the level of the ground considerably. A simple earthen bund 5,700 ft. long is recommended. (See section). This will probably breach through every year. The estimated cost is Rs. 35,000.

The expenses which would be incurred in the construction of a pucca bund is not justified by the return anticipated. The project is included in my list, however, as the villagers are most anxious for its construction, refusing at the same time to promise any definite increase to the revenue.

No. 7.—To complete the Tank at Malpur Naraina.—Plans and sections of the tank, as at present, are given in Appendix D, No. 4.

The estimated cost of completing the tank is Rs. 31,500. The villagers of Malpur Naraina much desire its construction. 500 bighas of land would be brought under cultivation in the bed.

The tank would appear to have been commenced years ago. During the famine of 1868-69 it was again taken up by Maharaja Madanpal, and about $\frac{3}{4}$ th completed. Since then nothing has been done, and as the waters of the nullah escape round one end, the face-wall, which is built on the ground without any foundation, has been here and there a good deal undermined. Owing to this the tank when made is certain to leak to a great extent, and there will always be a likelihood of the old portion of the bund giving way; not much more can be done to prevent this than is recommended in the Report and Estimate for completing the tank.

No. 8.—New Tank near Machilpur.—There is a good site for a tank here. I came across it when wandering about without any instruments, and was unable, in consequence, to take a section of the site. I note it, however, as a site where for about Rs. 10,000 a tank can be constructed capable of storing about 30 m. c.ft. of water, enough to irrigate 500 bighas. There are more than 1,000 bighas of good culturable land to the north of Machilpur; an irrigation duct will be required.

The catchment area is about $1\frac{1}{2}$ sq. miles of rock, and there ought then to be no difficulty in storing the quantity of water required.

No. 9.—Tank at Bond-ka-pura.—There are the remains of an old tank here, and a good tank can be made capable of irrigating 1,000 bighas. The project being an important one, detailed plans and estimates have been prepared. The construction of this tank is very much desired, and will be the making of two or three “puras” which have of late years been abandoned owing to want of water. (See Appendix D, No. 5).

No. 10.—Madan Sagar.—This tank was built by Maharaja Madan Pal and is named after him. It is not provided with a sluice.

The advisability of supplying one should be considered. There is a good deal of water stored yearly which at present is not brought into use, with the exception that singaras are grown in the tank bed. Culturable land below the tank bed can be found. The R. L. of weir is also very low, being only 10 ft. above the bed of the nullah and no less than 11 ft. below the top of the dam. A sluice costing about Rs. 2,000, and addition to weir costing about Rs. 800 recommended. (See Appendix D, No. 6).

No. 11.—Tank at Sohara.—There is a very good site for a tank here. Detailed plans and estimates have been prepared. The estimated cost of the dam is Rs. 16,271. The quantity of water which can be stored is estimated at 60 m. c.ft, the area which can be irrigated at 625 bighas, and the increase to the revenue at Rs. 1,875. The construction of this tank is much desired by the villagers. (See Appendix D, No. 7).

No. 12.—Tank at Basai.—There is a fair site for a tank here. Levels have shown, however, that the land commanded by the tank belongs to the village of Gadholi, which belongs to one of the Ranis. The position of the tank is noted for future use, should Gadholi hereafter revert to the State.

No. 13.—Tank at Balloopura.—A section of site and estimate of cost of the dam required are given in Appendix D, No 8.

The estimated cost is Rs. 19,500. The area which can be irrigated, 300 bighas in the bed, and 100 bighas below the bund.

The estimated increase to revenue is Rs. 1,200. It is probable that owing to the proximity of deep nullahs the water stored in the tank will be rapidly absorbed and drained off, and that consequently only in good years will it be possible to irrigate any land below the bund.

No. 14.—Tank at Reodor.—Asked for by the villagers, chiefly with a view to prevent their fields being cut away. Estimated cost Rs 3,800. About 100 bighas in the bed can also in a year or two be brought under cultivation. The expected return will therefore be about Rs. 300 per annum, or $7\frac{3}{4}$ per cent.

No. 15.—Sohara Tank.—A small tank to the south-east of Sohara, asked for by the villagers, chiefly for drinking purposes. No direct return can be anticipated.

No. 16.—*Tank at Golakra.*—A long and deep tank can be constructed here at a probable cost of Rs. 49,000. A large portion of the water stored cannot be used, and the land commanded is not very good. It is not a project which can be recommended.

No. 17.—*For a third Tank at Sohara.*—There is a good deal of good land to the north of Rosra which could possibly be irrigated from a tank at this site. This only struck me when I was riding away from Sohara, and I have not had an opportunity of going out there again.

No. 18.—*Tank at Lukmipur.*—A small tank wants to be repaired and cleaned out. Estimated cost Rs. 200.

No. 19.—*Tank at Totdhar.*—There is a good site for a tank here. Estimated cost Rs. 9,000. Estimated return Rs. 900, or 10 per cent. The villagers prefer the next site.

No. 20.—On the same nullah or just above No 22. It is a question as to which is the better site of the two. I think No 22. The villagers are anxious to have this dam at No. 20, as another 100 bighas of culturable land are thus secured. Estimated cost Rs. 14,800. Estimated return per annum Rs. 1,200, or 8·1 per cent. (See Appendix D, Nos. 9 and 10).

No. 24.—*Tank at Sillaoti.* The tank here wants to be cleaned out or otherwise repaired. Estimated cost Rs. 500.

Topographical Survey—Sheet No. 10 (a).

No. 1.—*Tank at Dargosi.*—By the constructing of a large dam over 96 ft. in height and at a cost of Rs. 450,000 it would be possible to construct a large tank here capable of irrigating all the land in the immediate neighbourhood of Karauli. Owing to the excessive height of dam required and to the velocity with which the stream descends, the project is not a good one, though at one time I thought that something might be made out of it. I simply include it now among the proposed tanks in order to direct attention to the perennial Barkheri stream, the waters of which, if they could be diverted on to the fields about Karauli city, would raise the value of the land fourfold. (See Appendix D, No. 11).

No. 2.—*Tank at Nindar.*—A large reservoir capable of storing about 384 m. c.ft. of water and of irrigating 4,000 bighas can be constructed here at an estimated cost of about Rs. 45,000. A complete report of this project, with the necessary plans, &c., has already been submitted as per Executive Engineer's No. 63 R, dated 18th May 1885. (See Appendix D, No. 12).

No. 3.—*Tank at Markakoa.*—There is a large tract of broken ground to the west of the village which could be brought under cultivation after two or three years, by the construction of a bund thrown across the gorge opposite the village. A tank in whose bed the greater portion of the

broken ground would be included would thus be formed. The water stored would be drained off and the bed cultivated. The estimated cost is Rs. 38,300, and the estimated increase to the revenue Rs. 600. (See Appendix D, No. 13).

No. 4.—*Tank at Khirak*.—For cultivation in bed. Estimated cost Rs. 10,700. Increase to revenue Rs. 500.

No. 5.—*Tank at Gopalpur*.—For cultivation in bed. Estimated cost Rs. 250.

No. 6.—*Tank at Moorla*.—For bed cultivation and to reclaim broken ground. Estimated cost Rs. 4,300. Estimated increase to revenue Rs. 200.

No. 7.—*Tank at Seapora*.—For cultivation below tank and to reclaim broken ground. Estimated cost Rs. 19,200. Estimated increase to revenue Rs. 1,500.

No. 8.—*Tank at Darrora*.—A small tank for rice cultivation. Estimated cost Rs. 10,800. Estimated increase to revenue Rs. 450.

No. 9.—*Tank at Manakhor*.—A small tank wanted here to store sufficient water to irrigate the rice crop. Estimated cost Rs. 14,750.

There is also a well under construction here at present for drinking purposes. It is estimated to cost Rs. 754.

The site selected is not a good one, and though it has now been sunk to 38 ft. there is not sufficient water in it to last through the summer months.

No. 10.—*Weir at Mohanpura*.—The project here is to throw a pucca masonry weir across the nullah below the village. The maximum height will be 10 ft. above the nullah bed, which is rocky all through. This weir will catch any silt coming down the nullah, and so in time form a large 40 bigha field in which rice can be grown. The villagers have in previous years thrown up small "pokhers" here with this object. They have, however, owing to the strength of the current, been regularly carried away. In small streams the system of temporary bunds answers well, and should the pucca weir here proposed answer expectations it will be possible to, in time, gradually form the beds of most of the nullahs in the Dang into terraced fields in which rice can, during the rains, be grown, by building pucca masonry weirs across them at suitable distances and sites. The development of this system, combined with the construction here and there of a large tank capable of retaining water all the year round, appears to me to be the best method for developing the resources of the Dang or hill tracts, and of inducing the cultivators to remain by these fields all the year round. At present from want of water a large area of the Dang is abandoned during the summer months, the cultivators only returning to their rice fields during the rains, and often not at all.

Nos. 11 and 12.—*At Pasala*.—Two small tanks for well and rice cultivation. Estimated cost Rs. 5,000 to 10,000. Estimated profit Rs. 250 to 450.

No. 13.—*Tank at Bherda*.—There is a small tank here, the bund of which has been slightly damaged. The repairs are estimated to cost Rs. 100, and are now being carried out.

No. 14.—*Mathapura*.—This tank was repaired in December 1888 by Overseer Abdul Majid. A separate report on the subject has already been made. The tank is calculated to store $7\frac{1}{4}$ m. c.ft., to irrigate 90 bighas, and ought in time to pay Rs. 240 per annum.

No. 15.—*Bund at Khoobnagar*.—A nullah was cutting away the fields here, and a bund with a masonry core was thrown across to prevent this. The bed is now silting up, and will soon be under cultivation. The cost has been Rs. 293, and the loss to the revenue prevented is estimated at Rs. 75.

Tanks generally.—In addition to the sites examined and reported on above, the Dang literally teems with sites for tanks of all sizes and for the construction of "pokhers," and the consequent formation of rice fields. Much can be done therefore by money judiciously spent in developing the latent resources of the favourable portions of these hill tracts, provided that by light assessments, good Government and the provision of drinking water, cultivators can be induced to take up land and settle. Of a considerable portion of this wild and broken portion of the State, however, nothing can be made.

Wells.—There is no part of the State included in this sheet where wells can be sunk with advantage. In the Dang the rocky nature of the soil, and in the low lands the depth of the sub-soil drainage, is against cheap well sinking. Here and there, however, sites for wells may be found. These places are :

- (1) Clay-covered valley in the Dang, as at Bhankri and Laugra, &c.
- (2) Along the nullah beds as at Nindar, Mar-ka-koah, &c.

Topographical Survey—Sheet No. 10 (b).

No. 1.—*Tank at Goosai*.—There is a very good site for a tank here, where, by the construction of a dam across a narrow and rocky gorge, a tank can be formed in whose bed 400 bighas of land can, after a year or a two, be brought under cultivation. The estimated cost is Rs. 6,000, and the expected increase to revenue due to the construction of the tank Rs. 3 per bigha, or Rs. 1,200. (See Appendix D, No. 14).

No. 2.—*Tank at Karanpur*.—By the construction of a dam here a tank can be formed in whose bed 200 bighas of land can, after a year or two, when the bed has to a certain extent silted up, be brought under cultivation.

The estimated cost of the dam and sluices is Rs. 10,000. The increase to the revenue ought at Rs. 3 per bigha to be Rs. 600 per annum. There are the remains of an old bund here.

No. 3.—Tank at Thorali.—There is a site to the north-east of the village where the villagers want a bund. The site is not a good one. It is, however, noted and estimated for. The chief objections to the site are:—

- (i) Want of good natural foundations and necessary cost in supplying them.
- (ii) Length of bund necessary, and
- (iii) Smallness of bed area.

The estimated cost of the dam and sluice is Rs. 20,700. The area which will ultimately be brought under cultivation is estimated at 300 bighas, and the consequent increase to revenue at Rs. 3 per bigha at Rs. 900 per annum.

No. 4.—Tanks at Simarah.—There are two old tanks here. The bed of one has silted up, and the villagers themselves being anxious to carry out the additions and repairs required, I have told them what I would advise them to do.

In the second one the dam has been breached and requires to be repaired. The benefit to be derived from the execution of the necessary repairs will be the upkeep of the present revenue. The project is not a good one.

No. 5.—Tank at Arora.—There is a very good site for a tank here, where, by the construction of a masonry dam across a narrow rocky gorge, a large tank with a bed area of about 2,000 bighas can be formed. A portion of the bed is already cultivated from wells which will be submerged.

Assuming, however, that at least 1,000 bighas of new land will be brought under wheat, and that the value of the land at present under cultivation will not be affected by the tank, the probable increase to the revenue will be $1,000 \times 3 = \text{Rs. } 3,000$.

The cost of the dam is estimated at Rs. 30,000. This is because a masonry in lime one appears to be here absolutely necessary, and for the following reasons:—

- (i) Because, for some distance above the site selected for the dam, the channel of the stream is considerably narrowed, and the velocity of approach thereby considerably increased. A plain earthen dam with a masonry core would probably not be strong enough to withstand the rush of water.
- (ii) Because the flood waters of the Chambal rise to 40 ft. above the nullah bed at the site of the proposed dam, and an earthen bund would be liable to damage from the floods. (See Appendix D, No. 15).

No. 6.—Nullahs near Rudai.—The nullahs in the neighbourhood of Rudai increase year by year, and in doing so, cut away a considerable portion of what is at present good culturable land. This gradual encroachment on good land is also common in similar tracts elsewhere, as already noticed. The best way to stop this regular encroachment would be to build an earthen bund quite round the nullah causing the damage.

Wells.—Along the nullahs, which in this sheet flow from the Dang or Highlands to the Chambal, wells can be sunk with advantage, provided cultivators can be induced to come forward and take up land.

There are acres and acres of good culturable soil lying idle. The depth at which water is met with is small, seldom exceeding 40 ft., and often only some 20 ft.

The chief difficulty appears to be want of cultivators—nor does this portion of the State appear to have been in former years cultivated to a greater degree than at present, as is the case in other portions of the State. My enquiries as to why this should be the case have elicited replies to the effect that the inhabitants depend, and have for years depended, for their living chiefly on their flocks and herds. They are not agriculturists. To secure, therefore, the development of the tract under notice, it will be necessary to, in some way, chiefly by promises of light assessments, either induce the present inhabitants to take up land or to attract outsiders.

Topographical Survey—Sheet No. 42.

No. 1.—Dahra Tank.—This tank was built some few years ago at a total cost of about Rs. 30,000. The length of the bund is 4,300 r.ft., maximum height 38 ft. The bed area is about 500 bighas (7,500,000 s.ft.); capacity 97,500,000 c.ft. It has not filled properly for the last two years, owing probably to the existence of one or two tanks above it. No sluice was originally provided, and as the land in the bed is cultivated, one is necessary, and is now being supplied at an estimated cost of Rs. 2,332. Should the tank fill well in future years a duct can also be supplied as shown on the map, at an estimated cost of Rs. 6,160.

No. 2.—Gotra Tank.—A large reservoir can be constructed here at an estimated cost Rs. 75,000, capable of storing 500 m.c.ft. of water and irrigating 5,000 bighas of land. A full report with necessary plans has already been submitted with Executive Engineer's No. 64 R of 18th May 1885. The increase to the revenue from the construction of this tank is estimated at Rs. 15,000. The project is a very good one. (See Appendix D, No. 16).

No. 3.—Tank at Garain.—This tank will only be required if the one at Gotra is found incapable of storing all the water which might run off the catchment. (See Report on the Gotra Tank).

No. 4.—*Tank at Kikrwa*.—A bund is wanted here by the villagers. The estimated cost is Rs 7,200, and the expected increase to revenue Rs. 200, or 2½ per cent.

No. 5.—*Tank at Jairota*.—A bund to dam up a nullah and reclaim a good deal of broken ground. Estimated cost Rs. 2,600: estimated increase to revenue Rs 600, or 16¾ per cent.

No. 6.—*Bund at Jairota*.—An ordinary earth bund required. Especially asked for by the villagers. Estimated cost Rs 1,150: estimated increase to revenue Rs. 100, or 9 per cent.

No. 7.—*Tank at Mandho*.—The estimated cost is Rs. 6,900. The villagers are constructing the tank themselves.

No. 8.—*Tank at Kharkhura*.—To the west of Dahra there is an old tank which has been breached for years. Its repair is recommended. Estimated cost Rs. 3,000.

No. 9.—*Tank below the present Dahra Tank*.—A section of the site is given in Appendix D, No. 17.

The construction of a bund here will reclaim 500 bighas of broken ground, which can, when reclaimed, be irrigated from the Dahra Tanks. The estimated cost is Rs. 17,000, and the increase to the revenue is estimated at Rs 1,500.

No. 10.—*Tank at Sipotra*.—By throwing a bund across the narrow gorge in the hills between Sapotra and Nisana about 100 bighas of good cultivable land can be submerged, and when the water has been drained off, cultivated. The estimated cost is Rs. 5,200, and the estimated increase to the revenue Rs. 300.

No. 11.—By the construction of a weir between the two small hills to the north-west of Amargarh, the water level in the bed of the Amerwad naddi could be raised, and the land on both sides of the stream, which belongs to the Thakur of Amargarh and Rountia, be brought under cultivation by the construction of wells. Estimate not taken out.

No. 11 (a).—*Tank at Amargarh*.—This tank is now under construction for the Thakur of Amargarh. It is estimated to cost Rs. 16,927.

The bed area is about 2,000 bighas, of which ½ (or 1,000 bighas) can be brought under cultivation. The estimated return is Rs. 3,000 per annum, or about 17 per cent. (See Appendix D, No. 18).

No. 12.—*Bund at Amerwar*.—The object of this dam is to reclaim a large tract of broken ground and to allow of its being cultivated when reclaimed. The site is a good one. The bed area will be about 300 bighas. (See Appendix D, No 19).

No. 13.—Tank at Lohera.—By the construction of a bund at the site shown on the plan a large tract (over 1,000 bighas) of good cultivable soil will be covered, and can, when the tank water has been drained off, be brought under cultivation. A section of the site is given in Appendix D, No. 20. The estimated cost is Rs. 21,500. The increase to the revenue is estimated at Rs. 1,500, or about 7 per cent.

No. 14.—Tank near Barsai.—There is no village near this site, and a large tract (over 1,000 bighas) of good cultivable land lies idle.

If any cultivators can, by the promise of the construction of the tank, be induced to come and settle, all this land could be utilized, and revenue of Rs. 3,000 per annum realized therefrom. The cost of the ^{project} ~~land~~ is estimated at Rs. 20,000. (See Appendix D, No. 21).

No. 15.—Tank at Attagwa.—A perennial stream passes here through a narrow gorge in the range of hills opposite to Attagwa. If it is banded a tank with a bed area of 400 bighas can be formed, and by regulating the sluices the area can be irrigated whenever required. Unfortunately there is no good land below the tank which can be irrigated therefrom, and the cultivation will have to be confined to the bed. The construction of the tank may lead to the reclamation of the broken ground below the bund. Omitting this, however, for the present, the area which can be brought under cultivation is estimated at 300 bighas, and the cost of the dam, &c., at Rs. 14,500.

No. 16.—Tank No. 2 at Attagwa.—By the construction of a short but high bund here a small and deep tank capable of storing 42 m.c.ft. of water, from a catchment area of about two sq. miles, can be formed. The estimated cost is Rs. 17,500, and the area of land (partly rice fields) which can be irrigated therefrom 500 bighas.

No. 17.—At Thom.—The villagers want a bund here. As its construction would, however, cut off some of the water falling on the catchment area of the Dahra Tank, its construction is not recommended.

Topographical Survey—Sheet No. 43.

No. 1.—Tank at Nynei Gouri.—This tank is under construction and approaching completion. The probable cost will be Rs. 20,000. The cubical contents are estimated at 48 m. c.ft.; the area commanded at 400 bighas. An additional 300 bighas can be brought under cultivation by the construction of a duct, which is estimated to cost Rs. 1,000. The anticipated revenue is Rs. 1,200 per annum, or 6 per cent., or if the duct is constructed Rs. 800, which is a return of 86 per cent. on the probable cost of the tank and duct combined, viz., Rs. 21,000. This tank fills well, and will hold water all the year round. This will be a great boon to the neighbourhood, where during the summer months there is no water, for drinking purposes even, to be had for miles round.

No. 2.—Tank at Maidpura.—This is an old tank which is now being repaired at an estimated cost of Rs. 1,992. A full report on it has already been submitted.

It is hoped that the improvements now being carried out may result in the tank retaining water, and consequent increase to revenue. If the tank dries up early in the winter, as it usually does, the upkeep of the present revenue is all that can be looked for.

No. 3.—Tank at Dowltpura Kalianpur.—Here, by closing up a narrow gorge, a large tank is formed. When the land in the bed has been thoroughly saturated the water stored is drained off and the bed cultivated. The bund is in a dangerous condition, and the bed is silting up. Proposals to strengthen the dam and to reduce the level of the scouring sluice, at an estimated cost of Rs. 5,600, have already been submitted.

No. 4.—Choudka (Bara).—The villagers of this place are most anxious for a tank. The two or three places pointed out by them are not suitable. A section for a small tank has been selected.

Further examination of the neighbouring hills may result in the discovery of a suitable site. If a site can be found there are acres of really good soil which would ensure the success of the tank.

No. 5.—Kanarda.—There is a capital site near the village of Kanarda for a "talao," a tank, in whose bed cultivation is carried on after the water stored has been drained off. The site for the proposed dam is a narrow and rocky one, and a high dam is not required to flood the bed area, which is a large one. The area of land in it which can at once be taken up is estimated at 800 bighas and another 200 would in time be also brought under cultivation. The estimated cost is Rs. 23,300, and the villagers are willing to let the State take half the outturn. This should yield at least Rs. 3 per bigha and give a return of Rs. 2,400 per annum, i.e., $800 \times 3 = 2,400$. This is a good project, and I would advise its being taken up at an early date. (See Appendix D, No. 22).

No. 6.—Tank at Gatw.—The site is a bad one. The estimated cost is Rs. 4,700, and the area which will in time be cultivated in the bed is 200 bighas. The increase to the revenue from the construction of this tank will probably be Rs. 600, or $12\frac{3}{4}$ per cent.

No. 7.—Tank at Deopur.—There is a site here for the construction of a very fair tank. Plans are given in Appendix D, No. 23. The estimated cost is Rs. 23,600.

The area of the land brought under cultivation by the construction of this tank ought in time to be 500 bighas and yield the State a revenue of Rs. 1,500 per annum, or about 6 per cent.

No. 8.—Tank at Nandpur.—There is an old tank here which needs repairs. The present tank leaks badly and does not hold water. The estimated cost of repairs is Rs. 4,276.

Wells.—There are not many parts included in this sheet where wells can be sunk with advantage. If cultivators can be induced to come forward and take up land in the valleys running from the "Dang" to the Chambal, a fair amount of land could in time be brought under "chahi" from wells. The present settlers are not agriculturists, and a large area of what would otherwise be land yielding a fair revenue is thus suffered to be idle.

IV.

APPENDIX B.

LIST OF EXISTING TANKS.

APPENDIX B.

LIST OF EXISTING TANKS.

- (i.) *Survey Sheet No. 8.*—Two near Darha, much damaged; repair of one recommended.
- (ii.) *Survey Sheet No. 8½.*—Tank at Dabra,
 Bund at Kharkara,
 „ „ Khora,
 „ „ Khubpur,
 „ „ Chaurpur,
 „ „ Kohra,
 „ „ Rachali,
 „ „ Dohara,
 „ „ Mokhandpur,
 and a number of small bunds in the neighbourhood.
 Tank at Sapatia,
 Tank on top of hill near Gotra,
 „ at Patpari,
 „ „ Kaia,
 „ „ Rajd.
- (iii.) *Survey Sheet No. 10 (a)*—Tank at Nynie Goari just ready.
 Tank at Maidpura,
 „ „ Dowlatpur,
 „ „ Jogipura, needs repair,
 „ „ Nandpur „ „
- (iv.) *Survey Sheet No. 10 (b).*—Tank at Ghani Gona, needs repair.
 „ „ Samara „ „ „
- (v.) *Survey Sheet No. 42.*—Tank at Meola.
 „ „ Chamarao'a,
 „ „ Sillali,
 „ „ Lakhimpur,
 „ „ Bhojpur,
 „ about Machipur,
 „ at Kasar (Madan Sagar),
 „ „ Mohan Khua.
- (vi.) *Survey Sheet No. 43.*—Three Tanks near Karauli,
 Tank at Dhaepura,
 „ „ Khoobnagar,
 Two Tanks at Markapura,
 „ „ „ Bherda,
 „ „ „ Manakhoor.
 Two Tanks at Mandrael,
 „ „ Gopalpur.

There must be, and doubtless are, several others of whose existence I am not aware. I hear of two large tanks in the Dang not noted above, one at a place called Deopur and one at Chawad. I cannot find these places on the map, and not having visited them cannot locate the sites.

V.

APPENDIX C.

TYPE SECTIONS OF DAMS AND WELLS,
WITH
APPROXIMATE ESTIMATE OF COST.

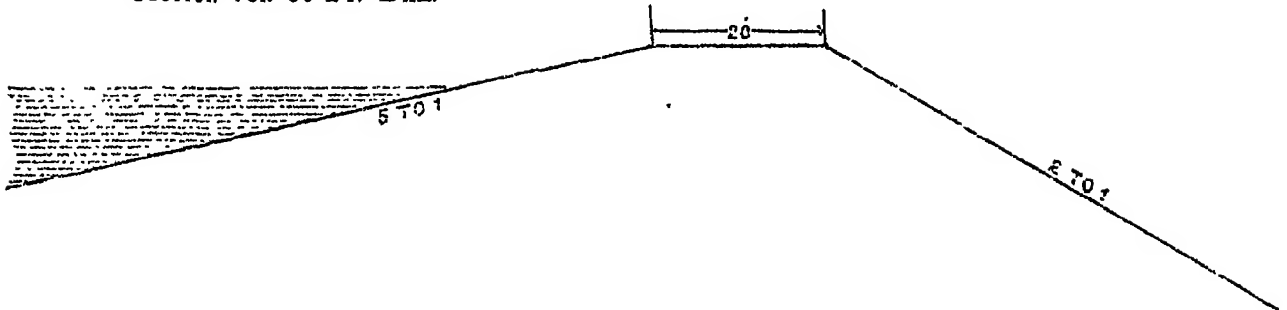
KARAU LI STATE.

TYPE SECTIONS OF DAMS.

Scale 20 ft. = 1 inch.

TYPE C.

SECTION FOR 50 FT. DAM.



Quantities per 100 R. F. of Length for each 5 ft. of Height.

5 Ft.	Earthwork Rs. 4 per 1,000.	Total Cost.	REMARKS.
	C. Ft.	Rs.	
1st	18,750	75	
2nd	36,250	145	
3rd	53,750	215	
4th	71,250	285	
5th	88,750	355	
6th	1,06,250	425	
7th	1,28,750	495	
8th	1,41,250	565	
9th	1,58,750	635	
10th	1,76,250	705	

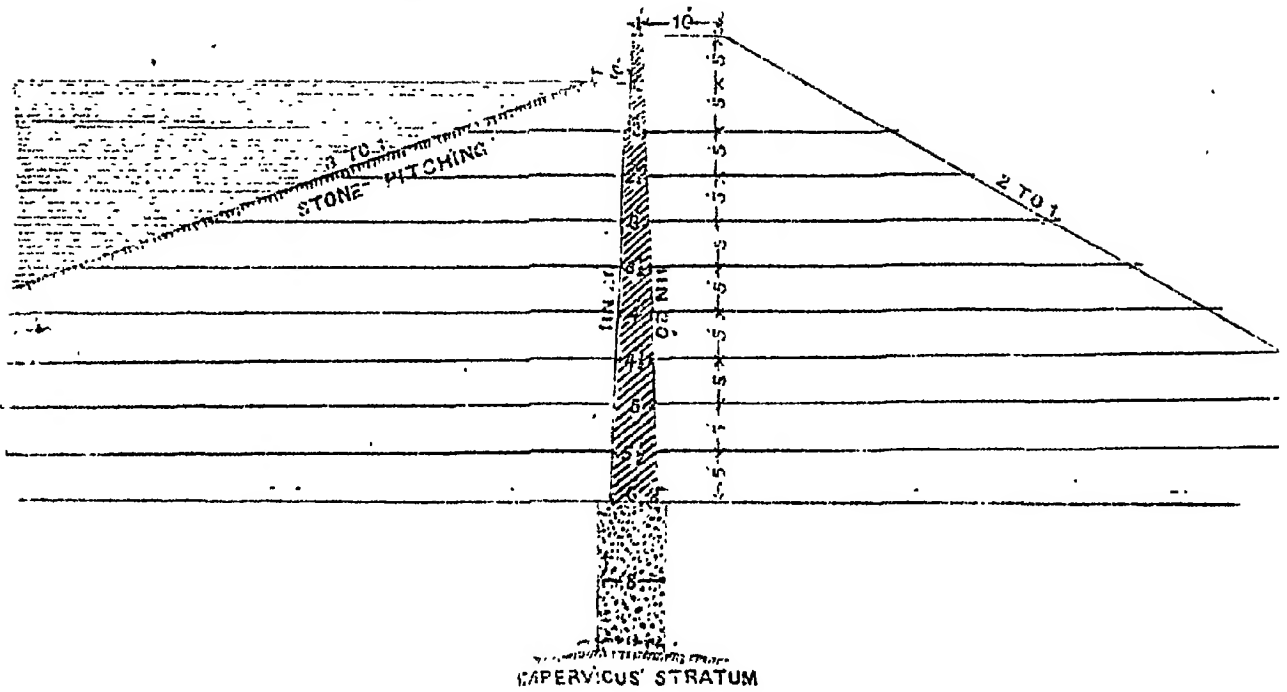
KARALI STATE.

TYPE SECTIONS OF DAMS.

Scale 20 ft. = 1 inch.

TYPE E.

SECTION FOR 50 FT. DAM.



Quantities per 100 R. F. of Length for each 5 ft. of Height.

5 Ft.	Masonry in Core Rs. 20 per 100.	Earthwork Rs. 4 per 1000.	Pitching Rs. 75 per 1581.	Total Cost.
1st	625 c.ft. 125 Rs.	7,500 c.ft. 30 Rs.	1581 75 Rs.	Rs. 155
2nd	750 c.ft. 150 Rs.	18,750 c.ft. 75 Rs.	1581 75 Rs.	300
3rd	1,000 c.ft. 200 Rs.	31,250 c.ft. 125 Rs.	1581 75 Rs.	400
4th	1,250 c.ft. 250 Rs.	43,350 c.ft. 175 Rs.	1581 75 Rs.	500
5th	1,500 c.ft. 300 Rs.	56,260 c.ft. 225 Rs.	1581 75 Rs.	600
6th	1,750 c.ft. 350 Rs.	68,750 c.ft. 275 Rs.	1581 75 Rs.	700
7th	2,000 c.ft. 400 Rs.	81,250 c.ft. 325 Rs.	1581 75 Rs.	800
8th	2,250 c.ft. 450 Rs.	93,750 c.ft. 375 Rs.	1581 75 Rs.	900
9th	2,500 c.ft. 500 Rs.	1,06,250 c.ft. 425 Rs.	1581 75 Rs.	1,000
10th	2,750 c.ft. 550 Rs.	1,18,750 c.ft. 475 Rs.	1581 75 Rs.	1,100

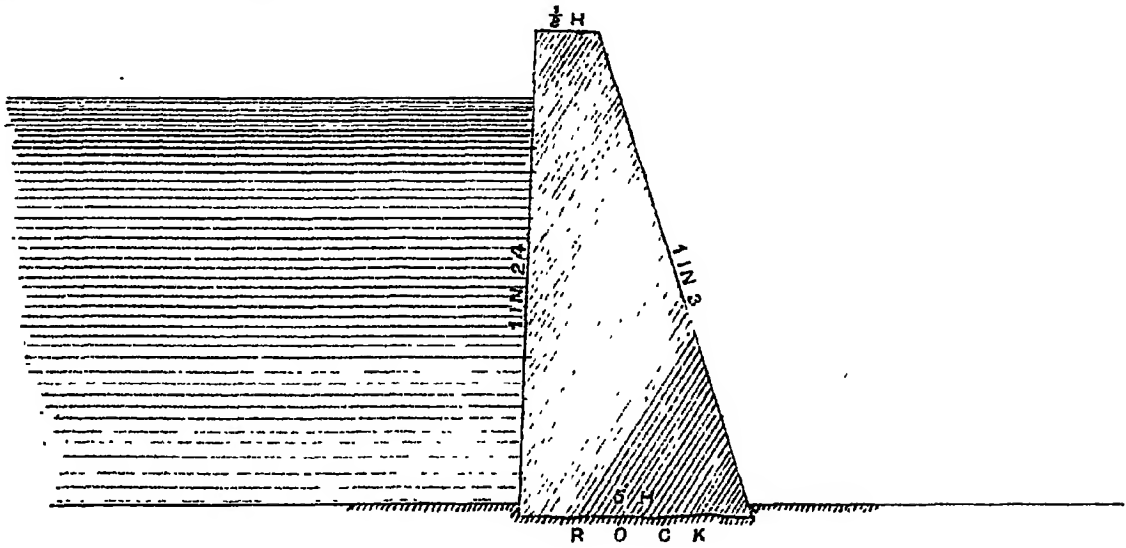
KARAULI STATE.

TYPE SECTIONS OF DAMS.

Scale 20 ft. = 1 inch.

TYPE H.

SECTION FOR 50 FT. DAM.



Quantities per 100 R. F. of Length for each 5 ft. of Height.

5 Ft.	Masonry in Lime C. Rs. 20 per 100.	Total Cost.
1st	C.ft. 750	Rs. 150
2nd	2,250	450
3rd	3,750	7,550
4th	5,250	1,050
5th	6,750	1,350
6th	8,250	1,650
7th	9,750	1,950
8th	11,250	2,250
9th	12,750	2,550
10th	14,250	2,850

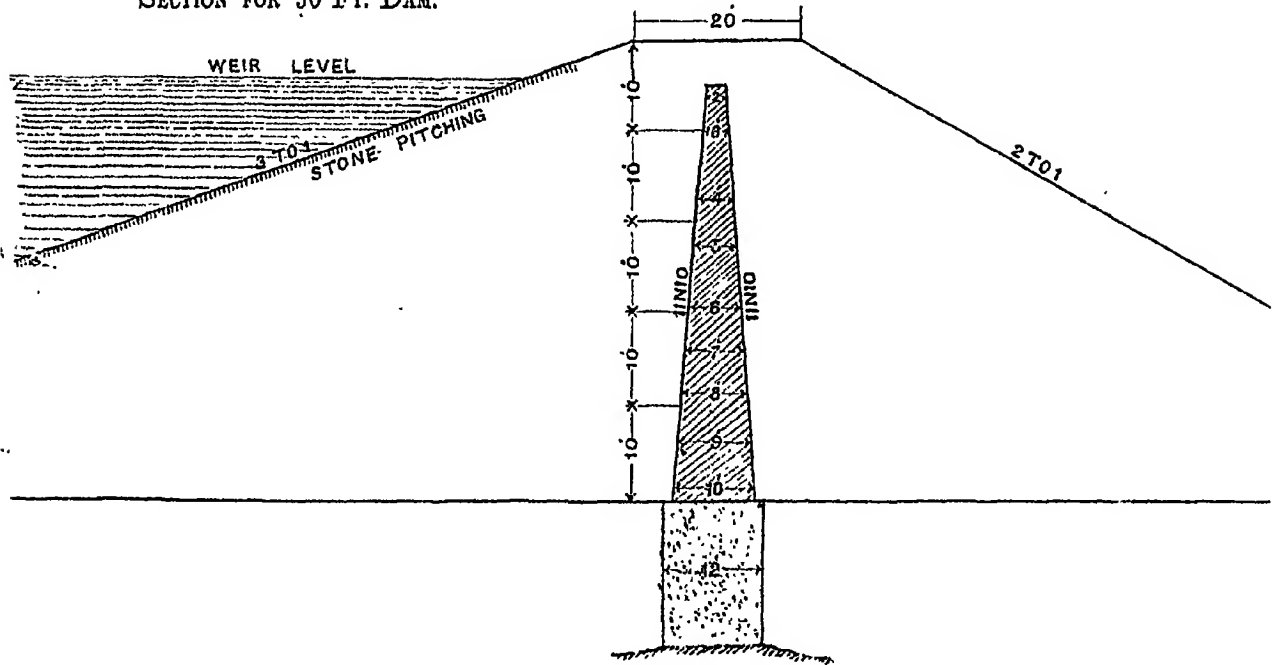
KARAU LI STATE.

TYPE SECTIONS OF DAMS.

Scale 20 ft. = 1 inch.

TYPE L.

SECTION FOR 50 FT. DAM.



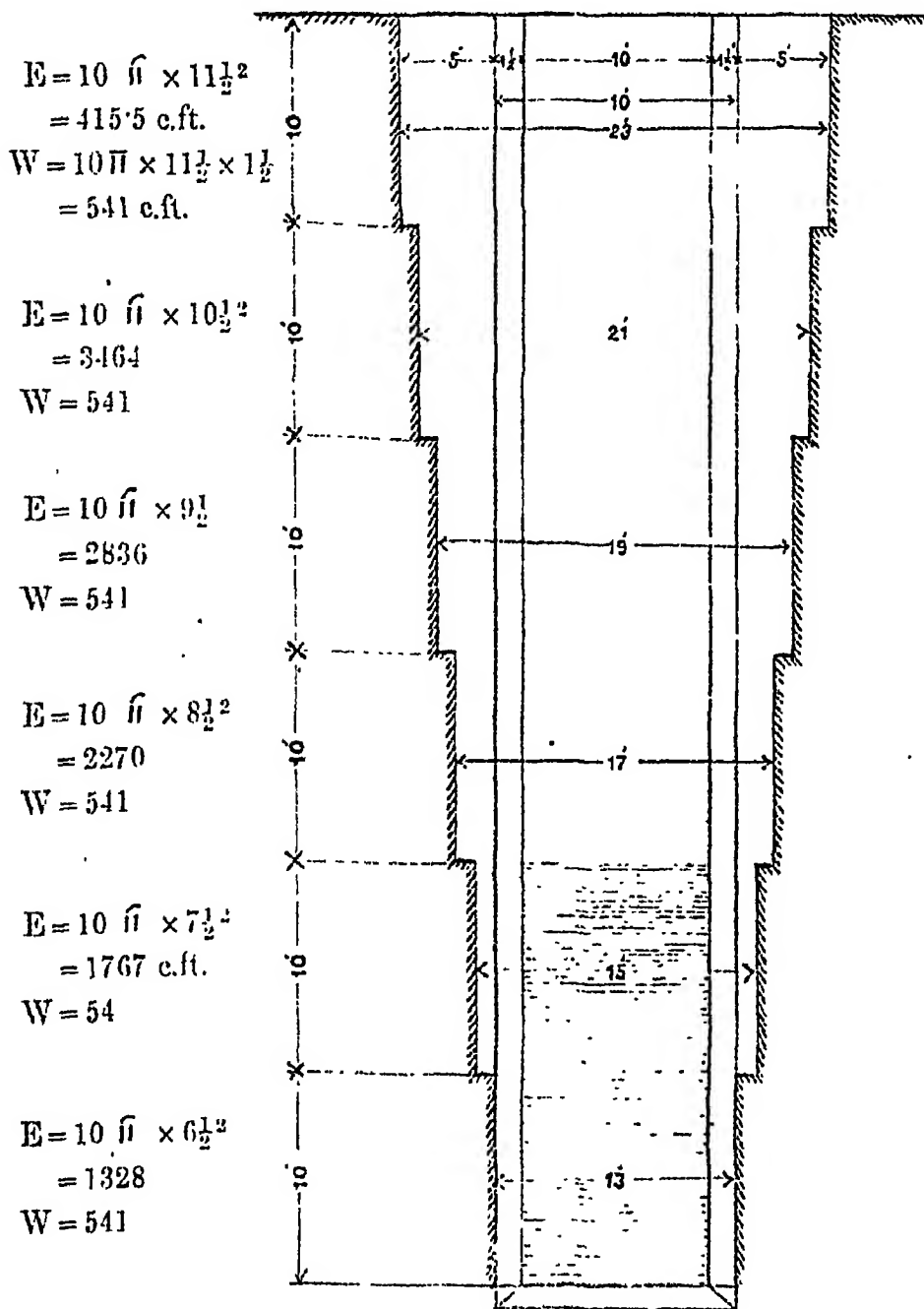
Quantities per 100 R. F. of Length for each 5 ft. of Height.

5 Ft.	Masonry in Core Rs. 20 per 100.	Earthwork Rs. 4 per 1000.	Pitching Rs. 80 per 1580.	Total Cost.
1st	.....	16,250 c.ft. 65 Rs.	790 c.ft. 40 Rs.	Rs. 105
2nd	1,000 c.ft. 200 Rs.	28,750 c.ft. 115 Rs.	1,580 c.ft. 80 Rs.	395
3rd	1,500 c.ft. 300 Rs.	41,250 c.ft. 165 Rs.	1,580 c.ft. 80 Rs.	545
4th	2,000 c.ft. 400 Rs.	53,750 c.ft. 215 Rs.	1,580 c.ft. 80 Rs.	695
5th	2,500 c.ft. 500 Rs.	66,250 c.ft. 265 Rs.	1,580 c.ft. 80 Rs.	845
6th	3,000 c.ft. 600 Rs.	78,750 c.ft. 315 Rs.	1,580 c.ft. 80 Rs.	995
7th	3,500 c.ft. 700 Rs.	91,250 c.ft. 365 Rs.	1,580 c.ft. 80 Rs.	1,145
8th	4,000 c.ft. 800 Rs.	1,03,750 c.ft. 415 Rs.	1,580 c.ft. 80 Rs.	1,295
9th	4,500 c.ft. 900 Rs.	1,16,250 c.ft. 465 Rs.	1,580 c.ft. 80 Rs.	1,445
10th	5,000 c.ft. 1,000 Rs.	1,38,750 c.ft. 515 Rs.	1,580 c.ft. 80 Rs.	1,595

KARALI STATE.

10 FT. DIAMETER OR TWO CHARUS WELL.

Scale 10 ft. = 1 inch.



Cost per 10 ft. of depth (see details).

For a Well 10 ft. deep = 124 Rs.

"	"	20	"	"	= 200 "
"	"	30	"	"	= 281 "
"	"	40	"	"	= 440 "
"	"	50	"	"	= 608 "
"	"	60	"	"	= 804 "

No. VI.

APPENDIX D.

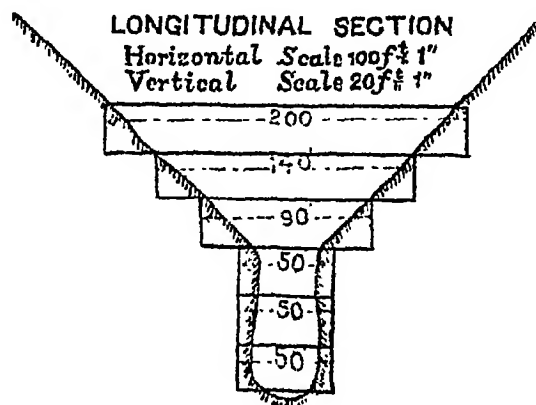
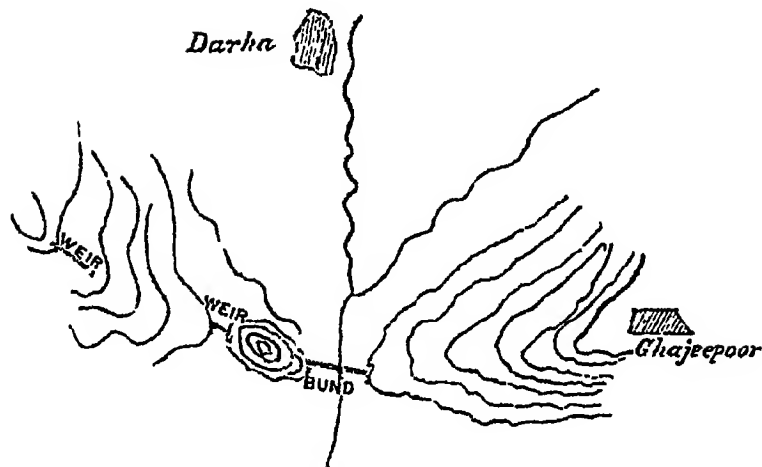
**PLANS AND SECTIONS OF PROPOSED TANK PROJECTS,
WITH
REPORTS AND APPROXIMATE ESTIMATES.**

Survey Sheet No 8.

SITE No. 2.

SKETCH OF GHAJEEMPOOR.

No. 1.

*Estimate with Core-wall (Type E).*

					Rs.
200 r.ft.	@ Rs. 155 per 100 r.ft.	...	=	310	
140 "	" " " 300 " " "	...	=	420	
90 "	" " " 400 " " "	...	=	360	
50 "	" " " 500 " " "	...	=	250	
50 "	" " " 600 " " "	...	=	300	
50 "	" " " 700 " " "	...	=	350	
200 "	Foundations @ Rs. 2 per ft.		=	400	
100 "	Masonry weir at Rs. 500 per ft.		=	500	
1 Scouring Sluice	...	...	=	500	
Total				...	3,390
Contingencies @ Rs. 10 per cent.				...	339
Total Estimated Cost				...	3,729

Estimate for Plain Earthen Bund.

				Rs.
200	r.ft.	@ Rs. 75	per 100 r.ft.	= 150
140	"	"	" 145 "	" " = 203
90	"	"	" 215 "	" " = 193
50	"	"	" 285 "	" " = 142
50	"	"	" 355 "	" " = 278
50	"	"	" 425 "	" " = 218
Weir and Sluice as above ...				... 1,000
Total ...				2,184
Contingencies at Rs. 10 per cent.				218
Total Cost				2,402

Say Rs. 2,400. Revenue Rs. 200, or $8\frac{3}{4}$ per cent.

N. B.—A core-wall would appear absolutely necessary at this site.

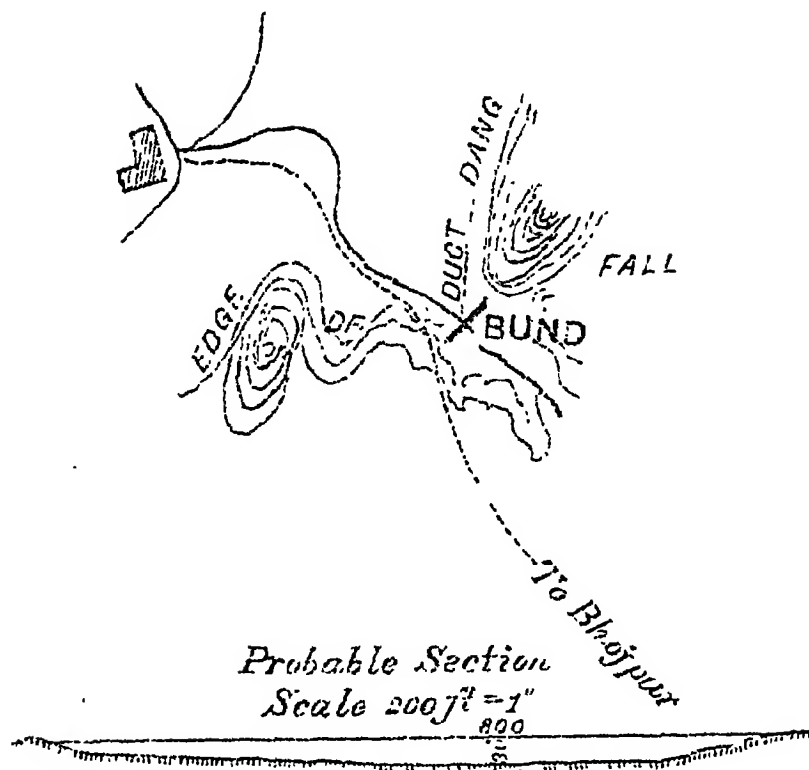
Area in bed 100 bighas. Probable increase to revenue Rs. 200 per annum. Indirect benefit great. (See General Report).

Survey Sheet No. 8.

SITE No. 3.

SKETCH OF TANK NEAR DARHA.

No. 2.



In the Dang. No section of site taken, as I had no instruments by me when I came across the site. It is a fair one.

A tank capable of irrigating 300 bighas could be constructed for about Rs. 8,000. (See General Report for further necessary details).

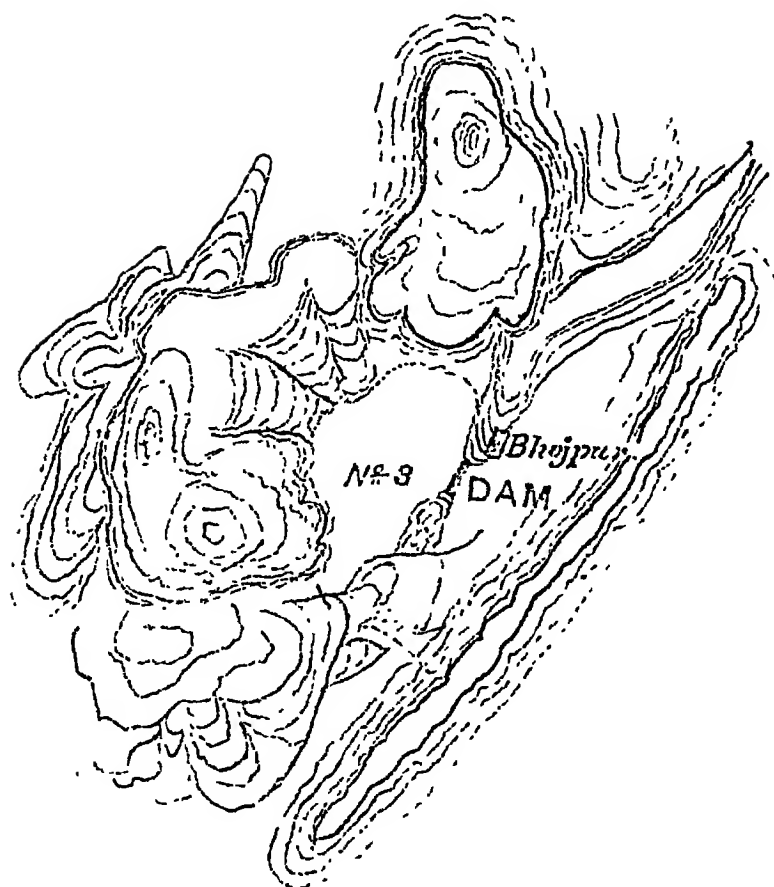
300 bighas should yield a revenue of at least Rs. 600 per annum, or $7\frac{1}{2}$ per cent. on the proposed expenditure.

Survey Sheet No. 8½.

SITE No. 3.

SKETCH OF BHOJPUR TANK.

No. 3.



It is, without doubt, the best sheet of water in Karauli. The tank bund leaks badly, and the sluices which conduct away the water which filters through require to be improved. (See General Report). A regular sluice might also, with advantage, be provided, and more use made of the water stored than is done at present.

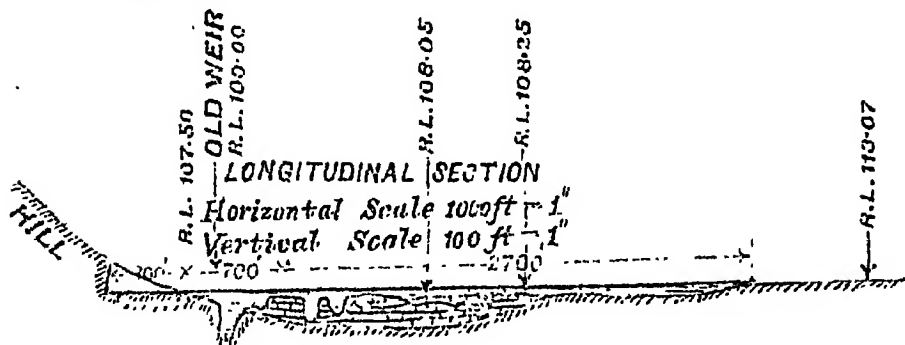
The cost would be some Rs. 2,000, and over 200 bighas of land could be brought under cultivation, and an increase to the revenue of Rs. 600 per annum or 30 per cent. then realized.

Survey Sheet No. 8 $\frac{1}{2}$.

SITE No. 7.

SKETCH FOR COMPLETING OLD TANK AT MALPUR NARAINA.

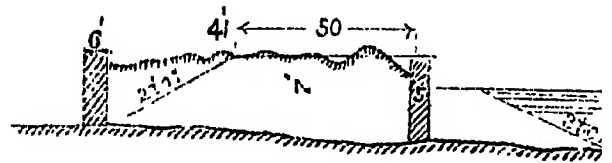
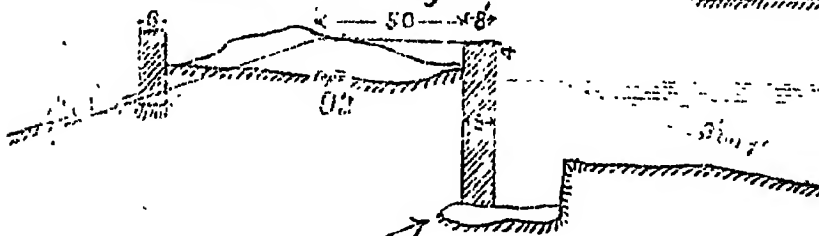
No. 4.



WEIR CUT IN ROCK

CROSS SECTION AT END

CROSS SECTION AT CENTRE

Horizontal Scale 50 ft = 1"
Vertical Scale 20 ft = 1"

(SEE GENERAL REPORT.)

Estimate.

Note.—Back wall to be dismantled and stones used in repairs to front wall.

(i.) Pointing front wall.—

	Rs.
$1 \times 3,700 \times 10 = 37,000$ s.ft. @ Rs. 3 per 100 s.ft. ...	= 1,110

(ii.) Earthwork.—

Front $1 \times 3,700 + 3\frac{3}{4} \times 10$...	= 6,26,000
Back (new portion) $1 \times 700 + 2\frac{1}{2} \times 20$...	= 2,80,000
In dressing back, &c., say ...	= 1,00,000

10,06,000

@ Rs. 4 per 1,000 c.ft. = 4,024

(iii.) Stone Pitching.—

Front $1 \times 3,700 \times 32$...	= 1,18,400
--------------------------------------	------------

@ Rs. 5 per 100 s.ft. = 5,920

(iv.) Masonry in Line.—

New portion $1 \times 700 \times 12 \times 8$...	= 67,200
Repairs $3 \times 120 \times 18 \times 18$...	= 51,840

1,19,040

@ Rs. 10 per 100 c.ft. = 11,904

(v.) Foundations under new portion, 700 r.ft. @ Rs. 4 per r.ft. = 2,800

(vi.) Weir cut in rock, 300 r.ft. @ Rs. 3 per r.ft. ... = 900

(vii.) Two Sluices, Rs. 1,000 ... = 2,000

Contingencies at Rs. 10 per cent. ... = 2,866

Total Cost ... 31,524

say Rs. 31,500.

500 bighas of broken land will be reclaimed and brought under cultivation and yield a revenue of Rs. 1,500 per annum, or $4\frac{3}{4}$ per cent.

Survey Sheet No. 8½.

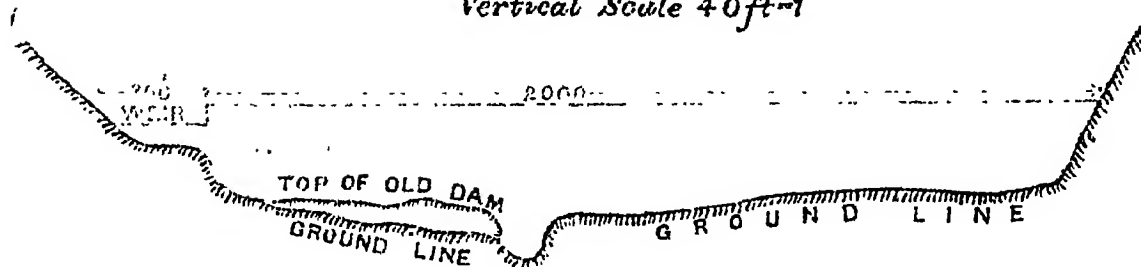
SITE No. 9.

SKETCH FOR TANK AT RUNDKAPURA

No. 5.



LONGITUDINAL SECTION
Horizontal Scale 400 ft=1"
Vertical Scale 40 ft=1"



There is a good site for a tank here. (See General Report, where detailed plans are given.) A sketch of site and cross section of the site are also given.

Estimate (Type M).

	Rs.
23,86,500 c.ft. Earthwork @ Rs. 4 per 1,000 c.ft. =	9,546
32,750 s.ft. Face-wall „ „ 30 per 100 c.ft. =	9,825
16,116 „ Pitching „ „ 5 „ „ „ =	806
300 r.ft. Masonry weir „ „ 5 per r.ft. ... =	1,500
2,300 „ Foundations „ „ 1 „ „ ... =	2,300
2 Sluices @ Rs. 500 =	1,000
	<hr/>
	24,977
Contingencies @ Rs. 10 per cent. ...	2,497
	<hr/>
Total Cost ...	27,474

or say Rs. 27,500.

Area irrigable 1,000 bighas.

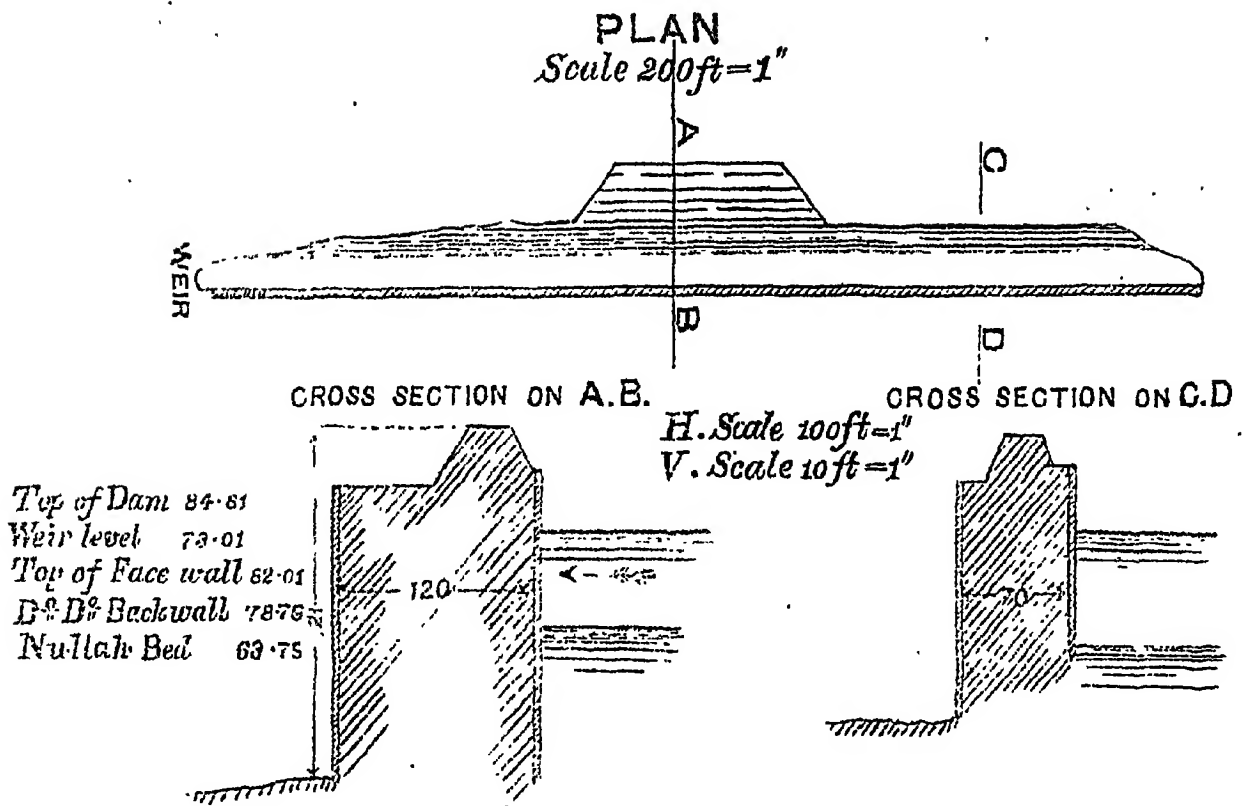
Expected revenue, Rs. 3,000, or 11 per cent.

Survey Sheet No. 8½.

SITE No. 10.

SKETCH OF TANK AT KASAR-MADAN SAGAR.

No. 6.



The tank has no sluice. One could, with advantage, be provided at a cost of Rs. 2,000, and the water stored in the tank thus utilized.

The weir level could also be raised with advantage. It is at present unnecessarily low, being no less than 11 ft. below the top of the dam and 8 ft. below the top of the front face-wall.

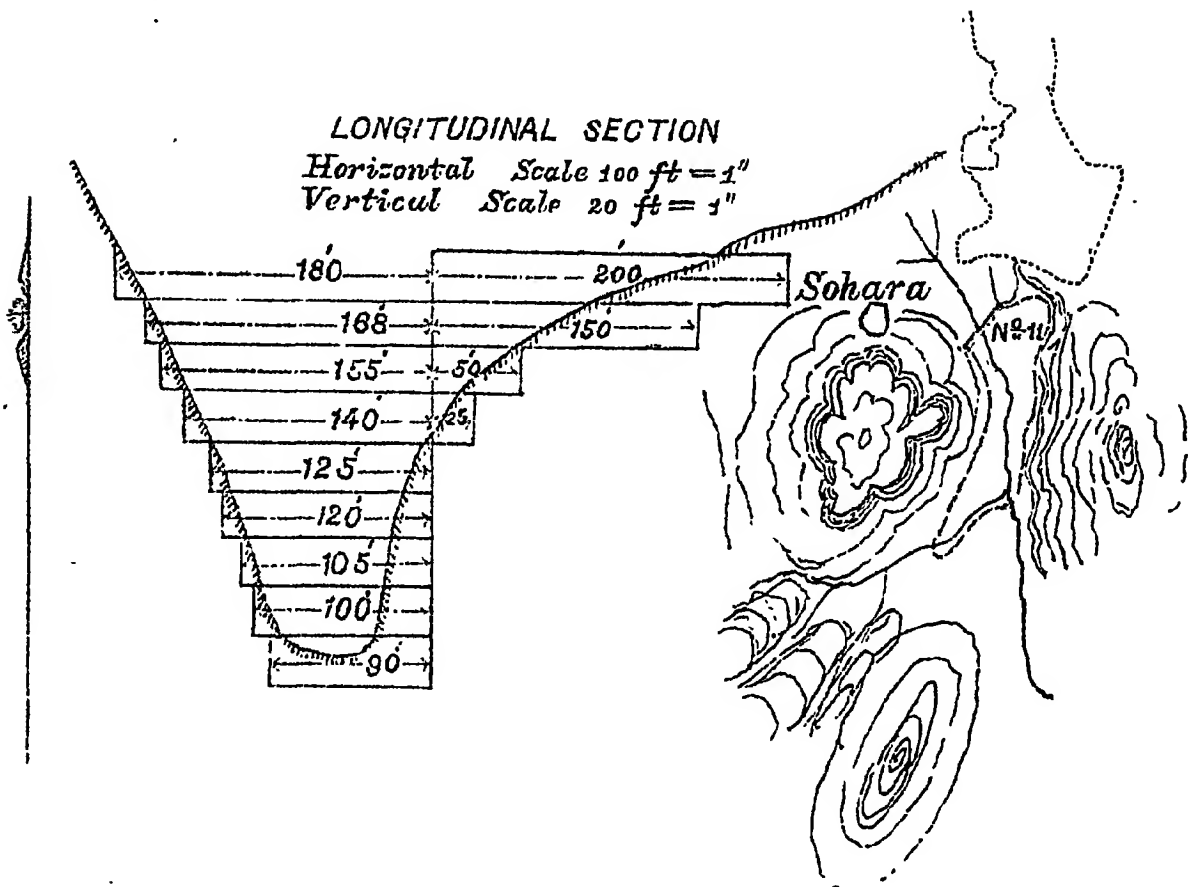
I would suggest that it be raised to within 5 ft. of the top of the dam, i.e., by 6 ft. Every drop of water coming down the nullah could then be stored. The cross section of the dam will show that it is quite strong enough to allow of the weir being raised as proposed. The estimated cost of raising the weir is Rs. 800 with extras. The total proposed expenditure may be put down at Rs. 3,000, and as at least 200 bighas of fair land can be brought under the influence of the tank and a probable revenue of Rs. 600 derived, the money would be well spent.

Survey Sheet No. 8 $\frac{1}{2}$.

SITE No. 17.

SKETCH OF SOHARA TANK.

No. 7.



There is a good site for a tank here, whereby the construction of a dam be estimated to cost only some Rs. 16,300. A large tank capable of storing 60 m. c.ft. of water and irrigating 625 bighas can be formed.

As the project is an important one, I have made out separate plans and estimates for it, for which an abstract of the estimate is given below. The increase to the revenue is estimated at Rs. 1,875, or 11 $\frac{3}{4}$ per cent. on the proposed expenditure.

Abstract of Estimate.

						Rs.
Masonry in lime dam	...	...	...	...	...	8,427
Earthen dam with core-wall	...	...	...	...	...	1,075
Masonry wing-wall	...	...	...	...	...	450
Foundation	...	...	...	...	...	1,340
Sluice	...	...	...	...	...	1,000
Duct	...	...	...	...	...	2,500
Total						14,792
Contingencies @ Rs. 10 per cent.						1,479
Total Cost						16,271

or say Rs. 16,300.

Survey Sheet No. 8 $\frac{1}{2}$.

SITE No. 13

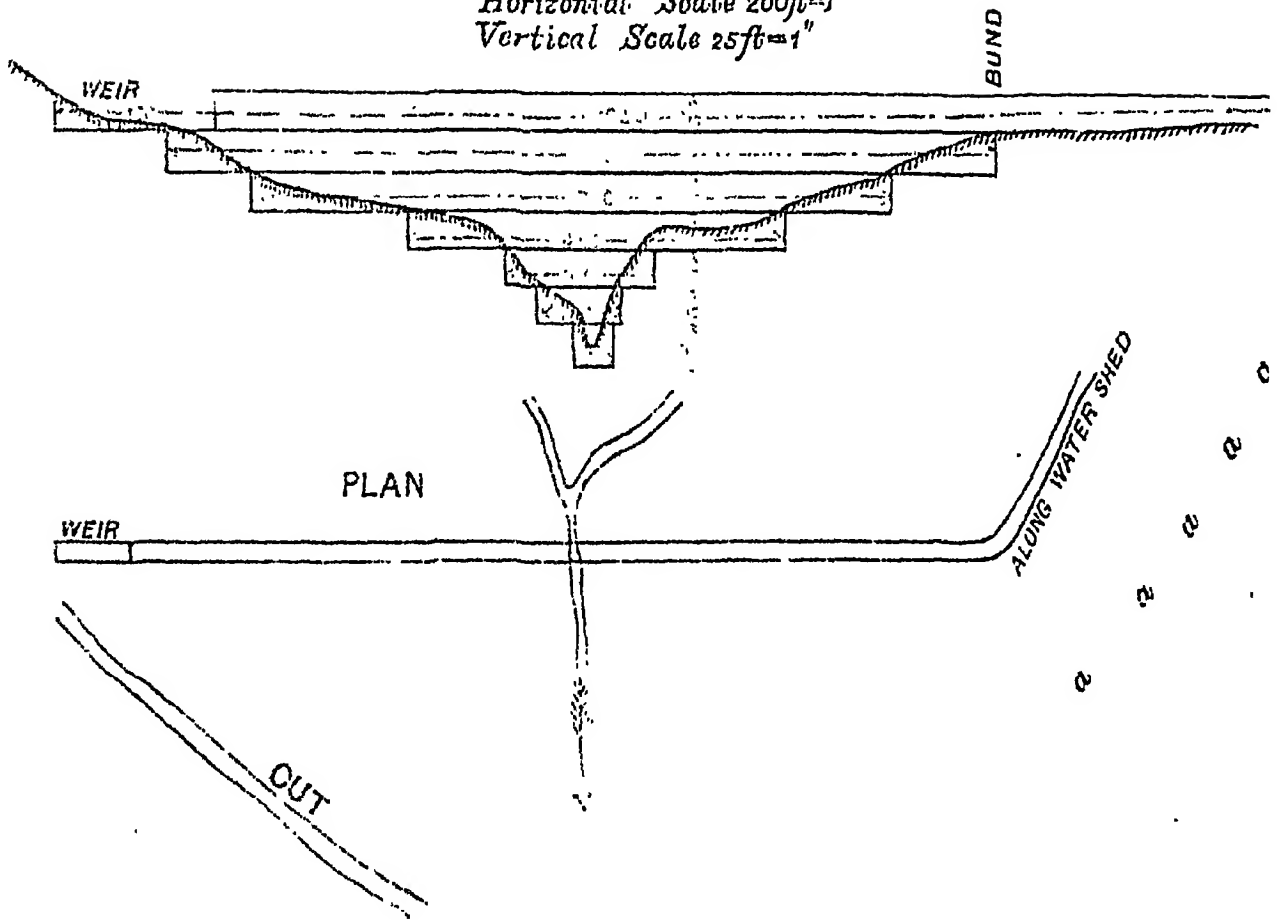
SKETCH OF BALUPURA TANK.

No. 8.

LONGITUDINAL SECTION

Horizontal Scale 200ft=1"

Vertical Scale 25ft=1"



There is a good site for a tank here. (See General Report).

Estimate (Type E).

							Rs.
1,050 r.ft.	@	Rs. 155	per 100 r.ft.	...	...	=	1,627
1,010	"	"	300	"	"	"	3,030
780	"	"	400	"	"	"	3,120
460	"	"	500	"	"	"	2,300
180	"	"	600	"	"	"	1,080
100	"	"	700	"	"	"	700
50	"	"	800	"	"	"	400
100	"	"	7	"	r.ft.	...	700
Sluice	...	...	...	...	...	=	1,000
1,200 r.ft.	Foundations @	Rs. 3	...	...	...	=	3,600
Total							17,557
Contingencies @ Rs. 10 per cent.							1,755
Total Cost							19,312

or say Rs. 19,500.

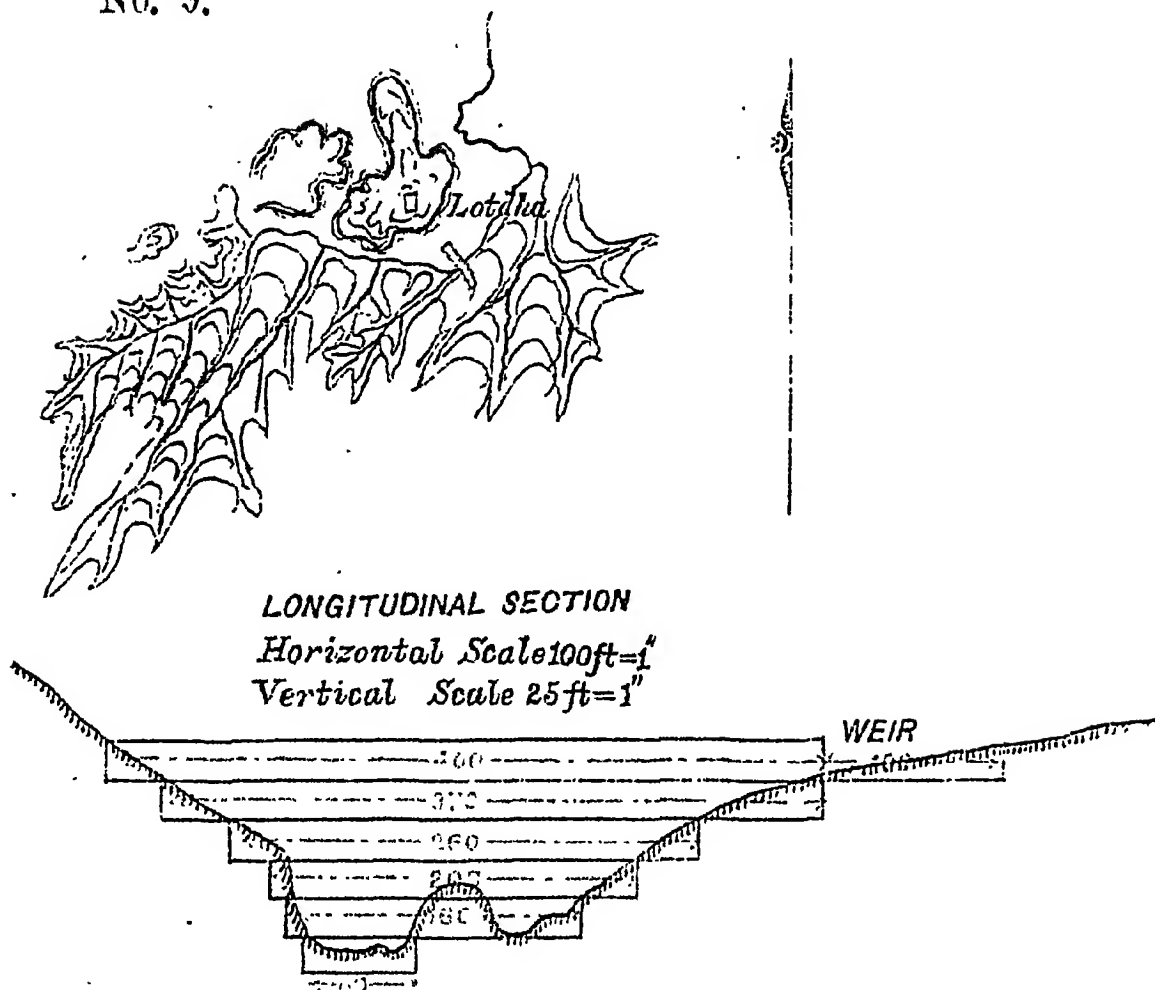
The area of land (in the bed) below tank, which can be brought under cultivation, is estimated at 400 bighas, and the probable increase to the revenue at Rs. 1,200 or 6.2 per cent.

Survey Sheet No. 8½.

SITE No. 19.

SKETCH OF LOTDHA TANK.

No. 9.



This is a good site for a tank, better, I think, than the next one. Only one of these is required. Before a definite opinion can be given as to which is the better one of the two, detailed plans will have to be got out, and the relative merits of the two sites compared. The villagers are anxious to have the tank at site No. 20. I think myself that site No. 19 is to be preferred.

Estimate of cost (Type E).

					Rs.
400 r.ft. @ Rs. 155 per 100 r.ft.	...	=	620		
370 " " " 300 " " " ...	...	=	1,110		
260 " " " 400 " " " ...	...	=	1,040		
200 " " " 500 " " " ...	...	=	1,000		
160 " " " 600 " " " ...	...	=	960		
60 " " " 700 " " " ...	...	=	420		
100 " Weir at Rs. 5 per r.ft.	...	=	500		
500 " Foundations at Rs. 3 ...	...	=	1,500		
1 Sluice .. .. .	...	=	1,000		
Contingencies at Rs 10 per cent. . . . .	...	=	815		
Total ...					8,965

or say Rs. 9,000.

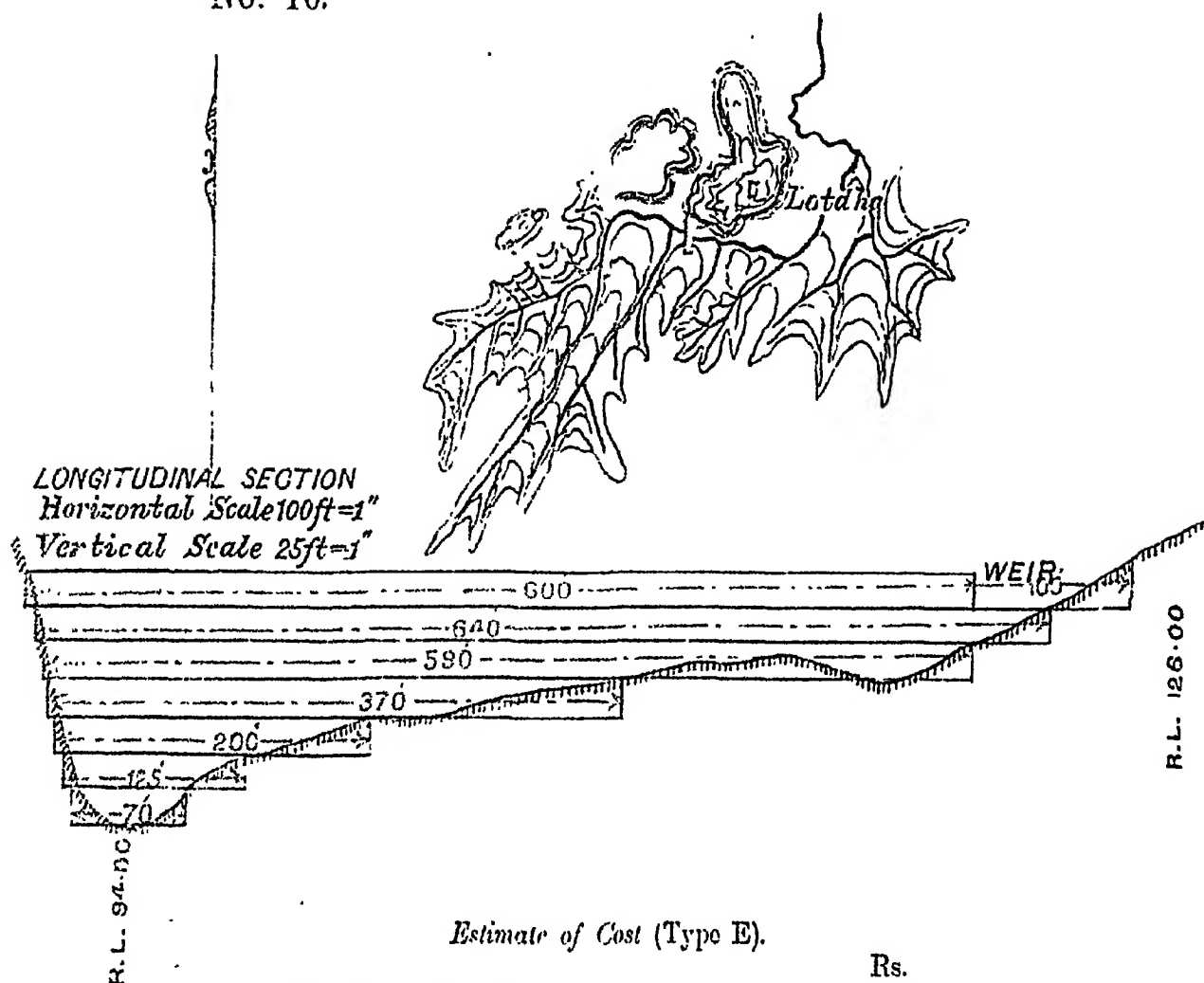
Area commanded and irrigable 300 bighas at Rs. 3 per bigha = Rs. 900, or 10 per cent.

Survey Sheet No. 8½.

SITE No. 20.

SKETCH OF 2ND TANK AT LOTDHA.

No. 10.



Estimate of Cost (Type E).

	Rs.
600 r.ft. @ Rs. 155 per 100 r.ft. ...	= 930
640 " " " 300 " " " ...	= 1,920
590 " " " 400 " " " ...	= 2,360
370 " " " 500 " " " ...	= 1,850
200 " " " 600 " " " ...	= 1,200
125 " " " 700 " " " ...	= 875
70 " " " 800 " " " ...	= 560
100 " Weir at Rs. 5 per r.ft. ...	= 500
750 " Foundations at Rs. 3 ...	= 2,250
1 Sluice ...	= 1,000
Total ...	13,445
Contingencies at Rs. 10 per cent. ...	1,344
Total Cost ...	14,789

or say Rs. 14,800.

Area commanded and irrigable 400 bighas at Rs. 3 per bigha =
Rs. 1,200 or 8.1 per cent.

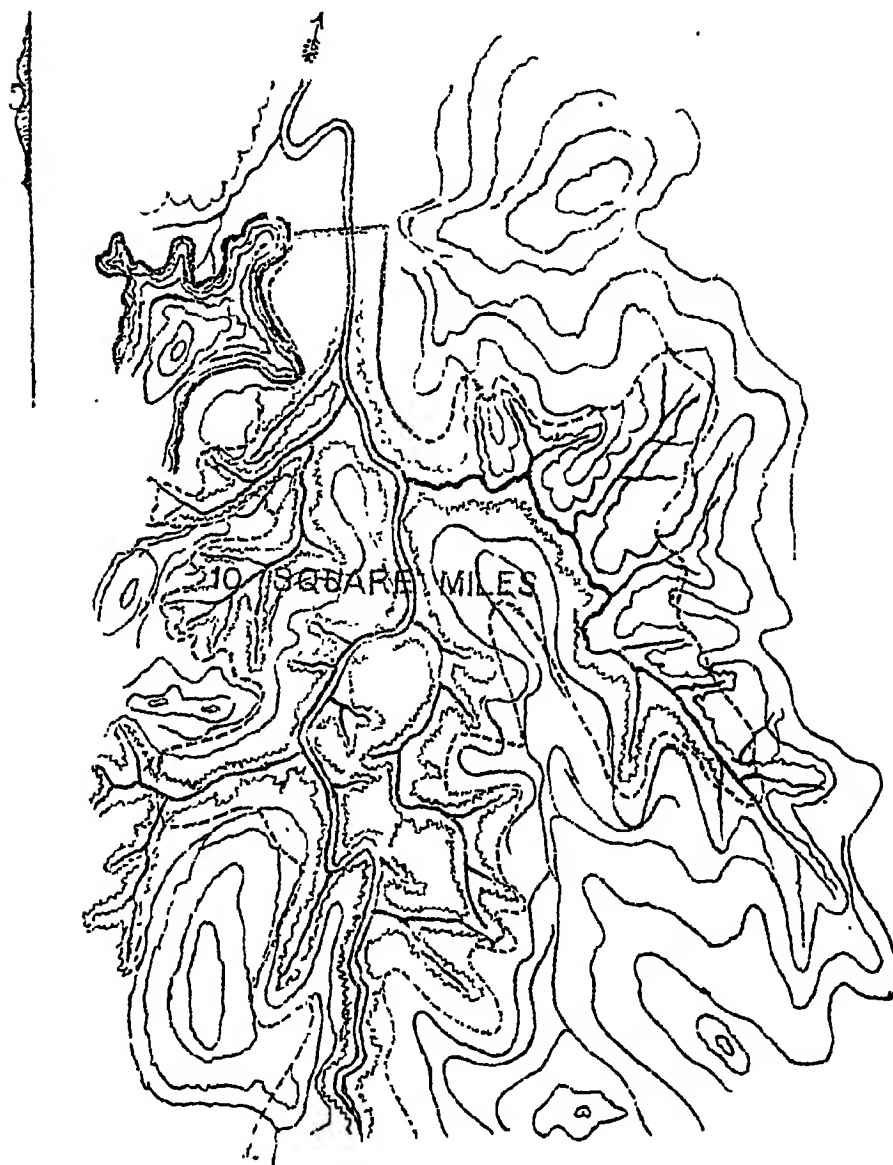
The villagers, who much desire a tank at this place, prefer this site (No. 20) to No. 19. The latter is, in my opinion, a cheaper and on the whole, though less land is commanded, a better one.

Survey Sheet No. 10 (a).

SITE No. 1.

SKETCH OF DURGOSI TANK.

No. 11.



An enormous tank over five miles long and two wide can be formed here by the construction of a dam 2,800 ft. long and 96 ft. high. The estimated cost is Rs. 4,50,000. (See General Report). The neighbourhood of Karauli could be irrigated therefrom. The length of the dam required is not excessive. The height, however, is against a large earthen dam. A masonry dam can be built, as a rocky foundation is obtainable across the entire width of the valley. It would cost a large sum owing to the depth at which the rock lies.

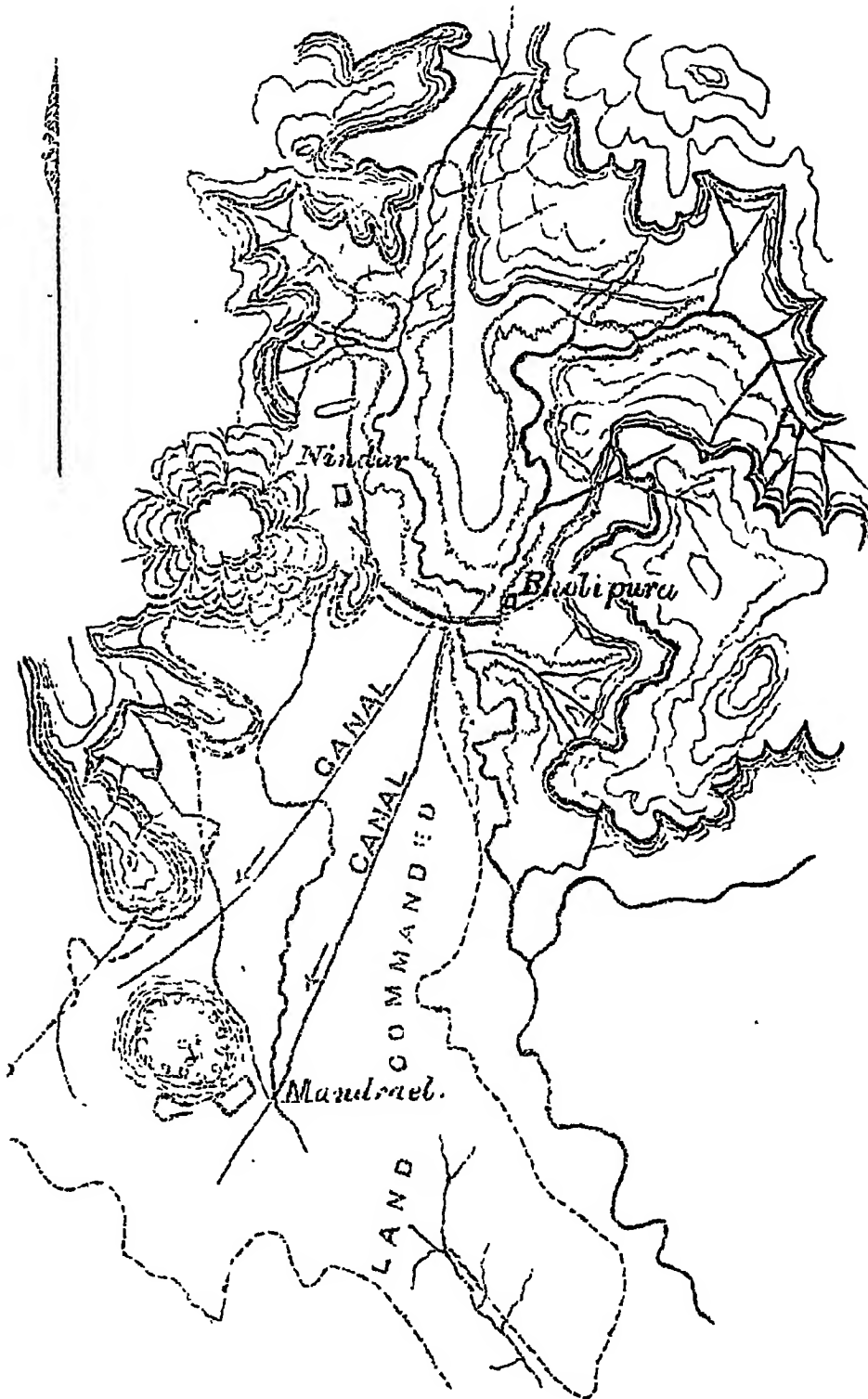
The project is one which might with advantage be worked out in detail. If in some way the waters of the perennial "Barkheri" could be diverted on to the land about Karauli, immense benefit would result therefrom. A separate note is put up on this project.

Survey Sheet No. 10 (a).

SITE No. 2.

SKETCH OF NINDAR TANK.

No. 12.



There is a good site here for a large reservoir. This is estimated to cost Rs. 44,347, to store 357 m.c.ft. of water, to irrigate 4,000 bighas and to yield an annual revenue of Rs. 10,000, or 22 per cent. on the anticipated cost, Rs. 45,000.

Complete details and plans have already been submitted with Executive Engineer's No. 63-K, dated 18th May 1885. A sketch of the site is given above. The section of dam adopted is that shown in Type L.

An abstract of the Estimate is given on next page.

Abstract of Estimate.

				Rs.
Main dam...	...	...	=	30,668
Protective Bunds...	...	...	=	2,633
Masonry Weir	...	...	=	2,015
Canals and Ducts...	...	...	=	5,000
		Total	...	40,316
		Contingencies at Rs. 10 per cent.	...	4,031
		Total Cost	...	44,347

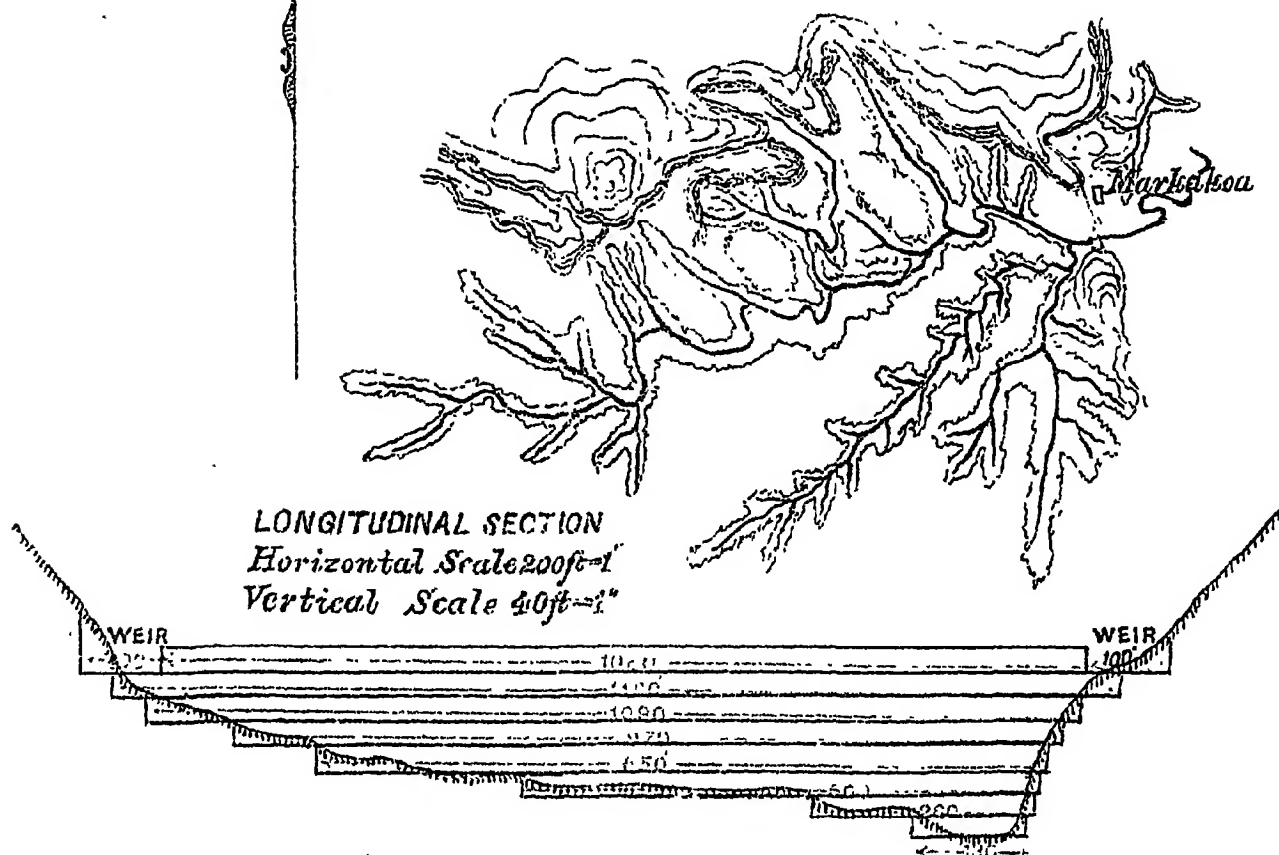
or say roughly Rs. 45,000.

Survey Sheet No. 10 (a).

Site No. 3.

SKETCH OF MARKAKOA.

No. 13.



There is a good site for a tank here, by which a large area of broken ground can be reclaimed.

Abstract of Estimate (Type E).

	Rs.
1,080 r.ft. @ Rs. 155 per 100 r.ft. ...	= 1,674
1,180 " " " 300 " " " ...	= 3,540
1,090 " " " 400 " " " ...	= 4,360
970 " " " 500 " " " ...	= 4,850
850 " " " 600 " " " ...	= 5,100
600 " " " 700 " " " ...	= 4,200
260 " " " 800 " " " ...	= 2,080
130 " " " 900 " " " ...	= 1,170
200 " Weir at Rs. 5 per r.ft....	= 1,000
1,200 " Foundations at Rs. 4 per r.ft.	= 4,800
2 Sluices at Rs. 1,000 each ...	= 2,000
Total ...	34,774
Contingencies at Rs. 10 per cent. ...	3,377
Total Cost ...	38,251

or say Rs. 38,300.

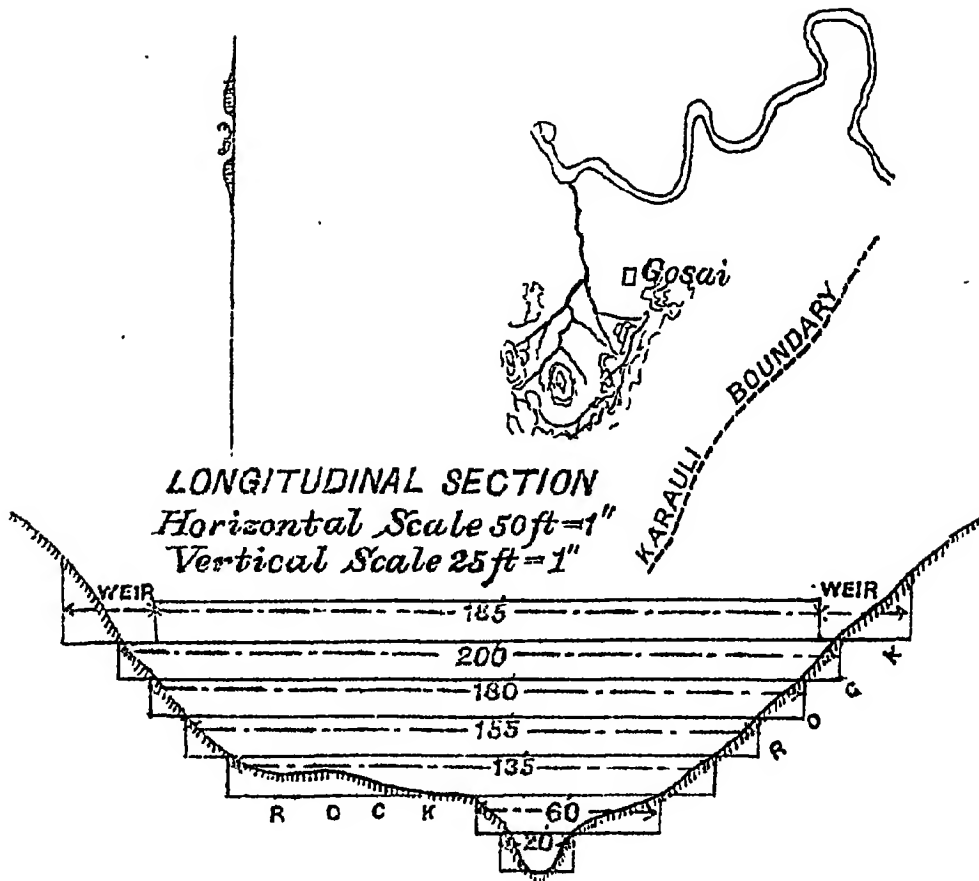
About 600 bighas in the bed can be counted on to yield Rs. 3 per annum or Rs. 1,800. This is 4·7 per cent. on Rs. 38,300.

Survey Sheet No. 10 (b).

SITE No. 1.

SKETCH OF GOSAI TANK.

No. 14.



A good site, (See General Report).

Estimate of Cost (Type E).

							Rs.
180 r.ft.	at Rs. 155	per 100 r.ft.	...	=			279
200 "	" "	300 "	" "	...	=		600
180 "	" "	400 "	" "	...	=		720
155 "	" "	500 "	" "	...	=		775
135 "	" "	600 "	" "	...	=		810
50 "	" "	700 "	" "	...	=		350
20 "	" "	800 "	" "	...	=		160
2 "	Weirs at Rs. 5	...	...	=			250
200 "	Foundations at Rs. 2	...	...	=			400
A Discharge Sluice	at Rs. 1,000	...	...	=			1,000
Total							5,344
Contingencies at Rs. 10 per cent.							544
Total Cost							5,888

or say Rs. 6,000.

Cultivation to be carried on in the bed of the tank. Estimated area, 400 bighas. Estimated increase to revenue at Rs. 3 = Rs. 1,200.

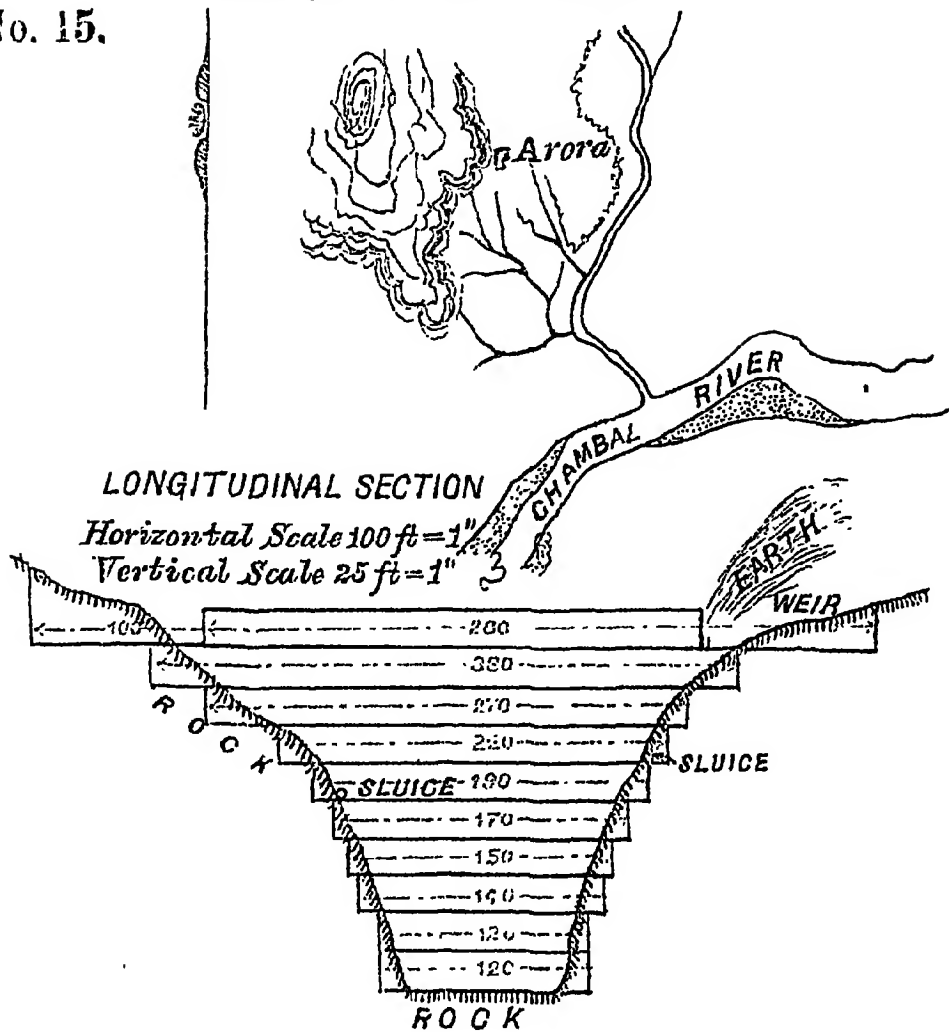
A good project.

Survey Sheet No. 10 (b).

SITE No. 5.

SKETCH OF ARORA TANK.

No. 15.



This is a good project. For further details see General Report.

Estimate of Cost (Type H).

					Rs.
280 r.ft. at Rs. 150 per 100 r.ft. ...	=	480			
330 " " " 450 " " " ...	=	1,485			
270 " " " 750 " " " ...	=	2,065			
220 " " " 1,050 " " " ...	=	2,310			
190 " " " 1,350 " " " ...	=	2,565			
170 " " " 1,650 " " " ...	=	2,805			
150 " " " 1,950 " " " ...	=	2,925			
140 " " " 2,250 " " " ...	=	3,150			
120 " " " 2,550 " " " ...	=	3,060			
120 " " " 2,850 " " " ...	=	3,420			
2 Weirs each 100 ft. long & cut in rock at Rs. 5	=	1,000			
2 Scouring Sluices, 30 inches high ...	=	1,000			
350 r.ft. Foundations at Rs. 3 ...	=	1,050			
	Total ...	27,315			
Contingencies at Rs. 10 per cent. ...		2,731			

Total Cost ... 30,046

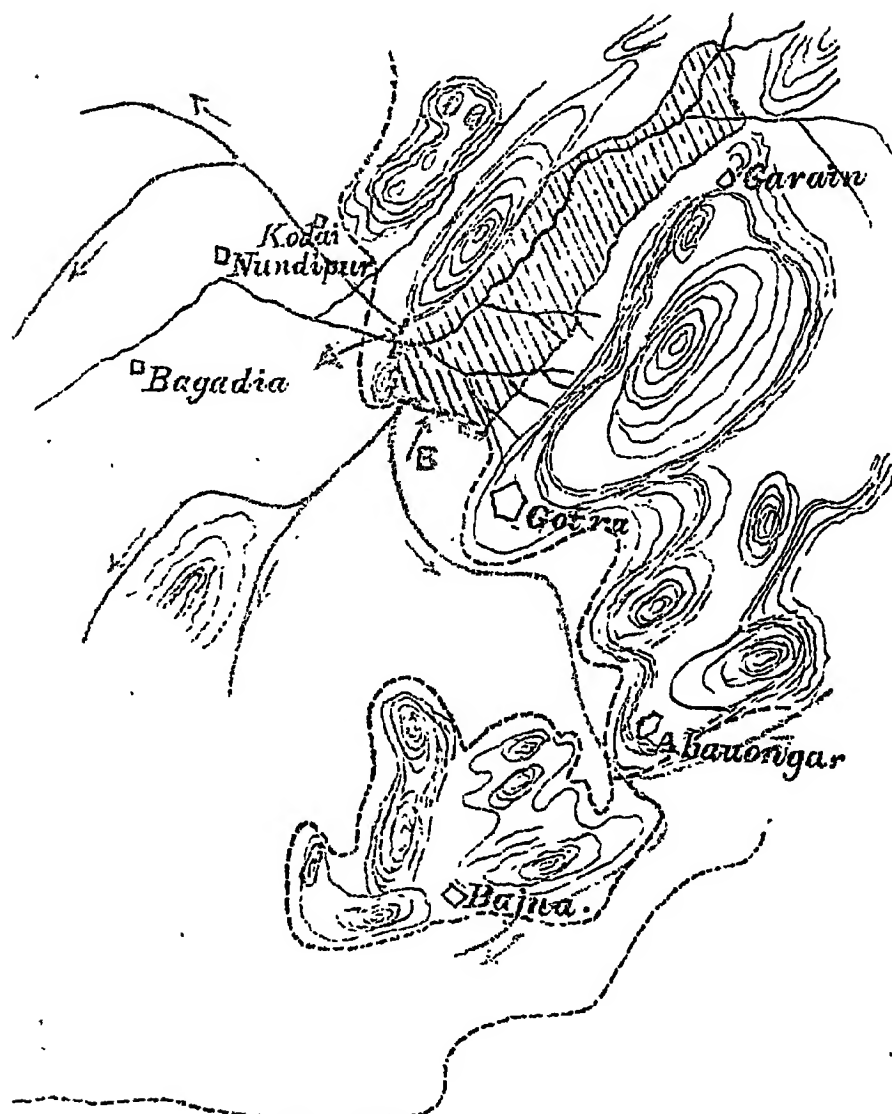
Culturable area 1,000 bighas at Rs. 3 per bigha = Rs. 3,000, or 10 per cent.

Survey Sheet No. 42.

SITE No. 2.

SKETCH OF GOTRA TANK.

No. 16.



A full report on this project has already been submitted. A reduced plan is given above, and an abstract of the Estimate below.

The tank is calculated to supply 500 m. c.ft. of water, to probably irrigate 5,000 bighas, and to yield an annual revenue of Rs. 15,000.

Abstract of Estimate.

				Rs.
Bund A	...	...	=	22,395
Bund B	...	...	=	39,461
Weir	...	...	=	348
Canals	...	...	=	5,000
				<hr/> 67,204
Contingencies at 10 per cent.	...			6,720
				<hr/>
Total Cost	...			73,924

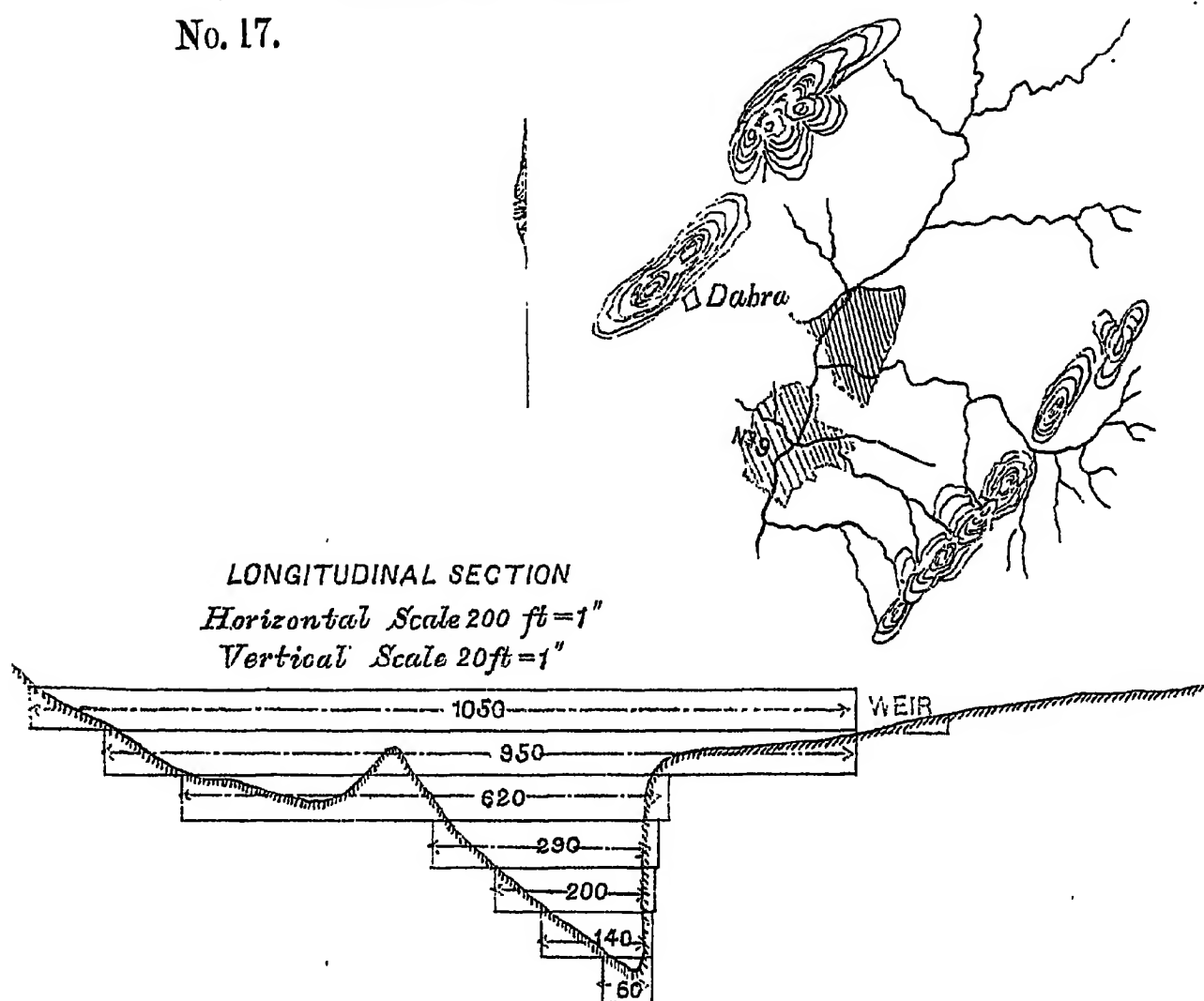
Return Rs. 15,000 on say Rs. 75,000, or Rs. 20 per cent.

Survey Sheet No. 42.

SITE No. 9.

SKETCH OF DABRA TANK No. 2.

No. 17.



To reclaim broken land which can afterwards be irrigated from the Dabra Tank.

Estimate of Cost (Type E).

			Rs.
1,050 r.ft. at Rs. 155 per 100 r.ft.	...	...	1,627
950 " " " 300 " " "	...	=	2,850
620 " " " 400 " " "	...	=	2,480
290 " " " 500 " " "	...	=	1,450
200 " " " 600 " " "	...	=	1,200
140 " " " 700 " " "	...	=	980
60 " " " 800 " " "	...	=	480
120 " Weir at Rs. 2 " " "	...	=	240
1,100 " Foundations at Rs. 3 ...	...	=	3,300
1 Discharge Sluice ...	...	=	1,000
			15,407
Contingencies at 10 per cent.	...	...	1,540
		Total Cost	16,947

or say Rs. 17,000.

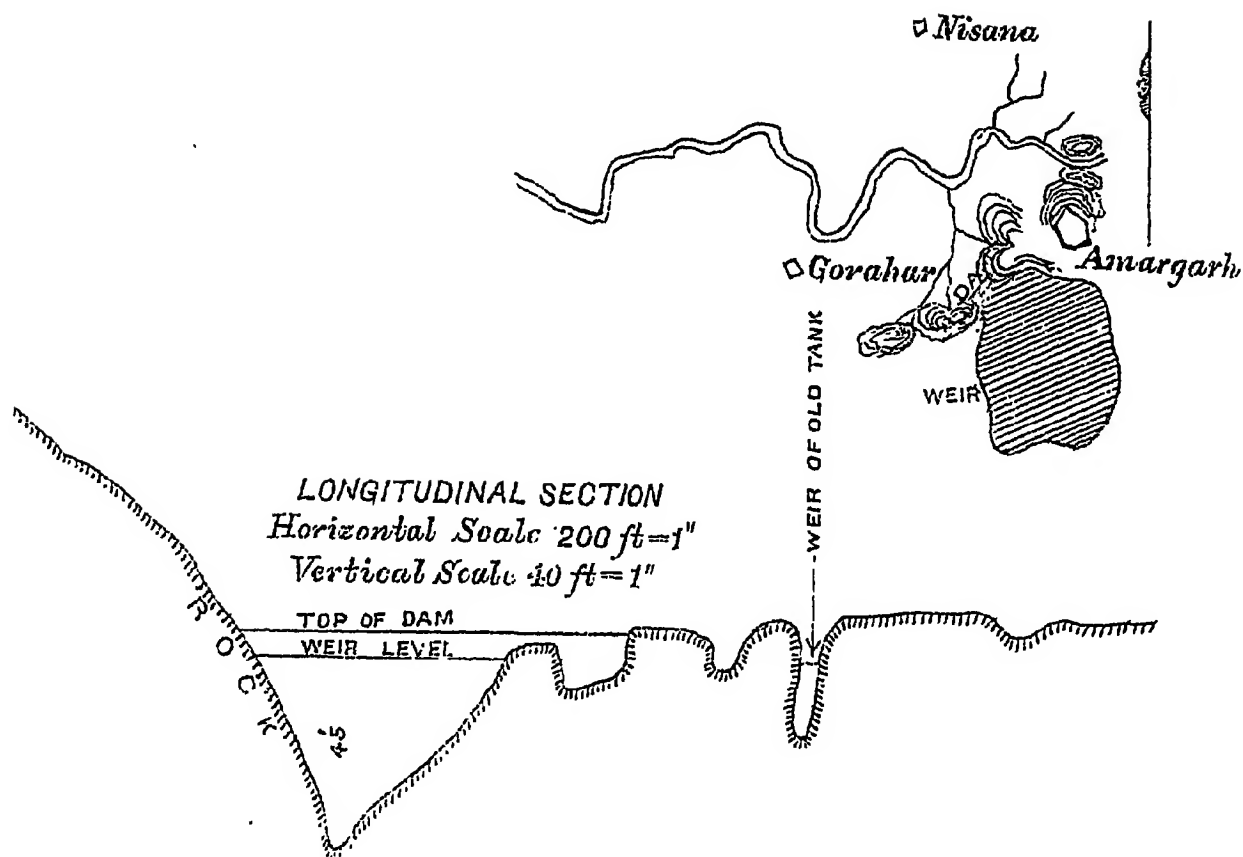
500 bighas at Rs. 3 = Rs. 1,500 or 9 per cent.

Survey Sheet No. 42.

SITE No. 11 (a).

SKETCH OF AMARGARH TANK.

No. 18.



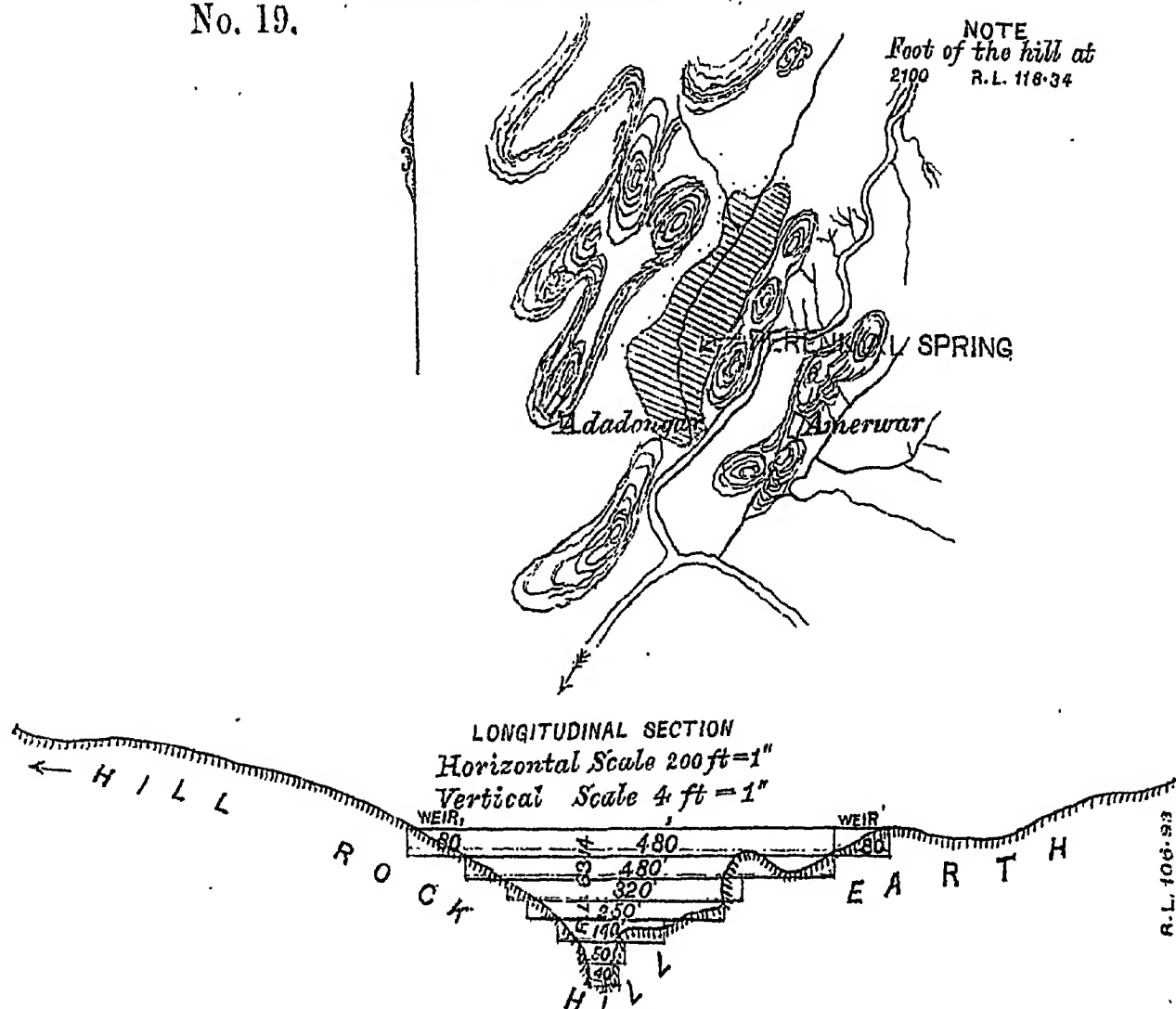
This tank is now under construction for the Thakur of Amargarh. It is estimated to cost Rs. 16,927 as detailed below. Two dams have on previous occasions been built here and have in each instance been carried away. They were badly built.

It is estimated that the water stored in the bed will cover 2,000 bighas, and that after it has been drained off, 1,000 bighas will be brought under cultivation and in time yield a revenue of Rs. 3,000.

Abstract of Estimate.

	Rs.
4,030 c.ft. Rock cutting in foundation at Rs. 25 per 1,000 c.ft. =	101
12,148 „ Concrete in foundation at Rs. 10 per 100 c.ft. =	1,215
49,546 „ Masonry in lime at Rs. 15 per 100 c.ft. ... =	7,432
7,16,314 „ Earthwork at Rs. 4 per 1,000 c.ft. ... =	2,865
22,150 s.ft. Stone-pitching at Rs. 10 per 100 c.ft. ... =	2,215
120 c.ft. Cut stone work in Sluice at Annas 8 per c.ft. =	60
1 Sluice 24" Diameter =	500
1 Weir in rock =	1,000
Total ...	15,388
Contingencies at Rs. 10 per cent.	1,539
Total Cost ...	16,927

NOTE
Foot of the hill at
2100 R.L. 118-34



There is a good deal of broken ground to the north-west of Amerwar, which the construction of a dam at the site shown above would reclaim. As the stream is here a perennial one the water level in the tank could, by regulating the sluice, be retained at any desired level.

Estimate of Cost (Type E).

Weir level 30' above nullah bed.

	Rs.
480 r.ft. @ Rs. 155 per 100 r.ft. =	744
480 " " " 300 " " =	1,340
320 " " " 400 " " =	1,280
260 " " " 500 " " =	1,300
140 " " " 600 " " =	840
50 " " " 700 " " =	350
40 " " " 800 " " =	320
2 80 ft. Weirs at Rs. 5 per ft. =	800
1 Discharge Sluice =	1,000
650 r.ft. Foundations at Rs. 3 per r.ft. =	1,950
	<hr/>
Total ...	9,924
Contingencies at Rs. 10 per cent.	992
	<hr/>
Total Cost ...	10,916

or say Rs. 11,000.

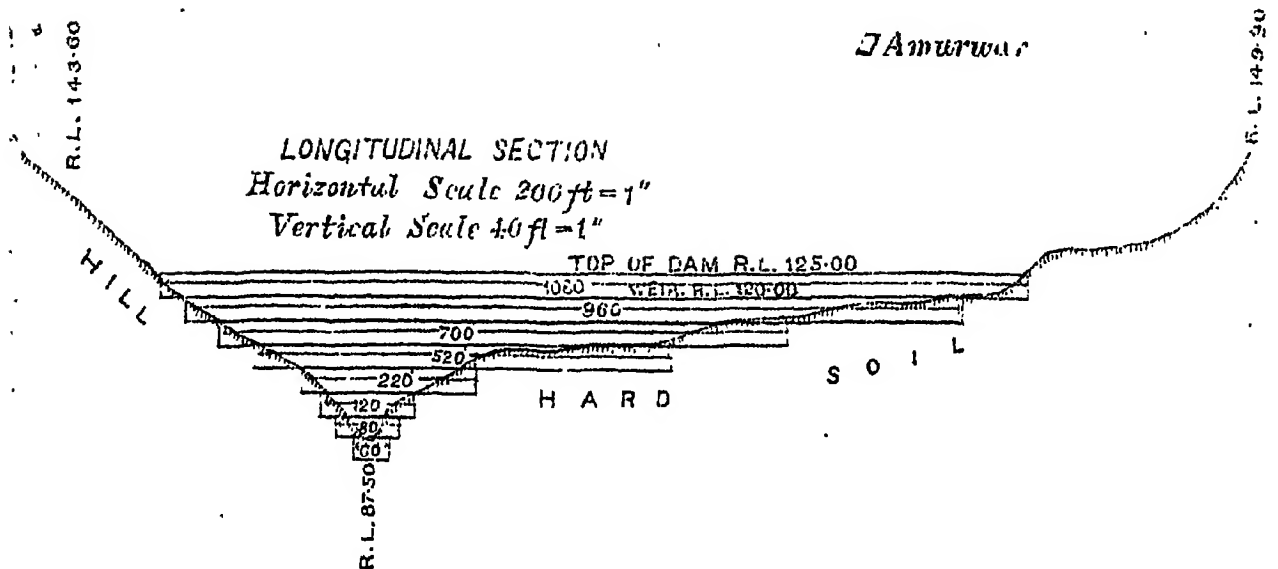
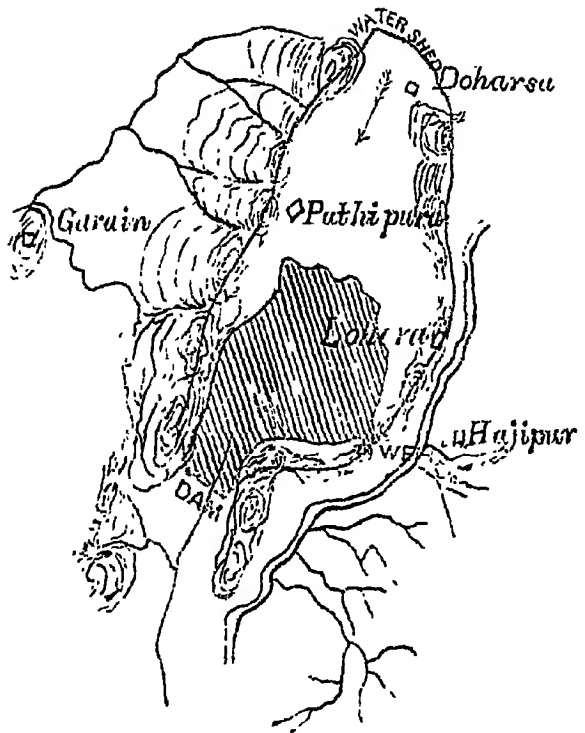
Culturable area 300 bighas at Rs. 3 per bigha = Rs. 900, or 8·2 per cent.

Survey Sheet No. 42.

SITE No. 13.

SKETCH OF LOHERA TANK.

No. 20.



There is a very good site for a tank here, by the construction of which, should it ever fill properly, nearly 1,000 bighas of good land can be brought under cultivation. The bed area being about 14,000,000 s.ft. and the average depth 7 ft., the cubical contents would be 108 m.c.ft., and a catchment area of $\frac{108}{2.1} = 5$ square miles is required.

The catchment is only three square miles. It is probable, therefore, that the tank will only quite fill in exceptionally good years; 500 bighas can then ordinarily be only reckoned on.

Estimate (Type E).

					Rs.
1,080 r.ft. at Rs. 155 per 100 r.ft.	...	=			1,674
960 " " " 300 " " "	...	=			2,880
700 " " " 400 " " "	...	=			2,800
520 " " " 500 " " "	...	=			2,600
220 " " " 600 " " "	...	=			1,320
120 " " " 700 " " "	...	=			840
80 " " " 800 " " "	...	=			640
60 " " " 900 " " "	...	=			540
200 " Weir at Rs. 7	...	=			1,400
1 Discharge Sloice	...	=			1,000
1,200 r.ft. Foundations at Rs. 3	...	=			3,600
					<hr/>
					19,294
Contingencies at Rs. 10 per cent.	...	=			1,924
					<hr/>
					Total Cost .. 21,223

or say Rs. 21,500.

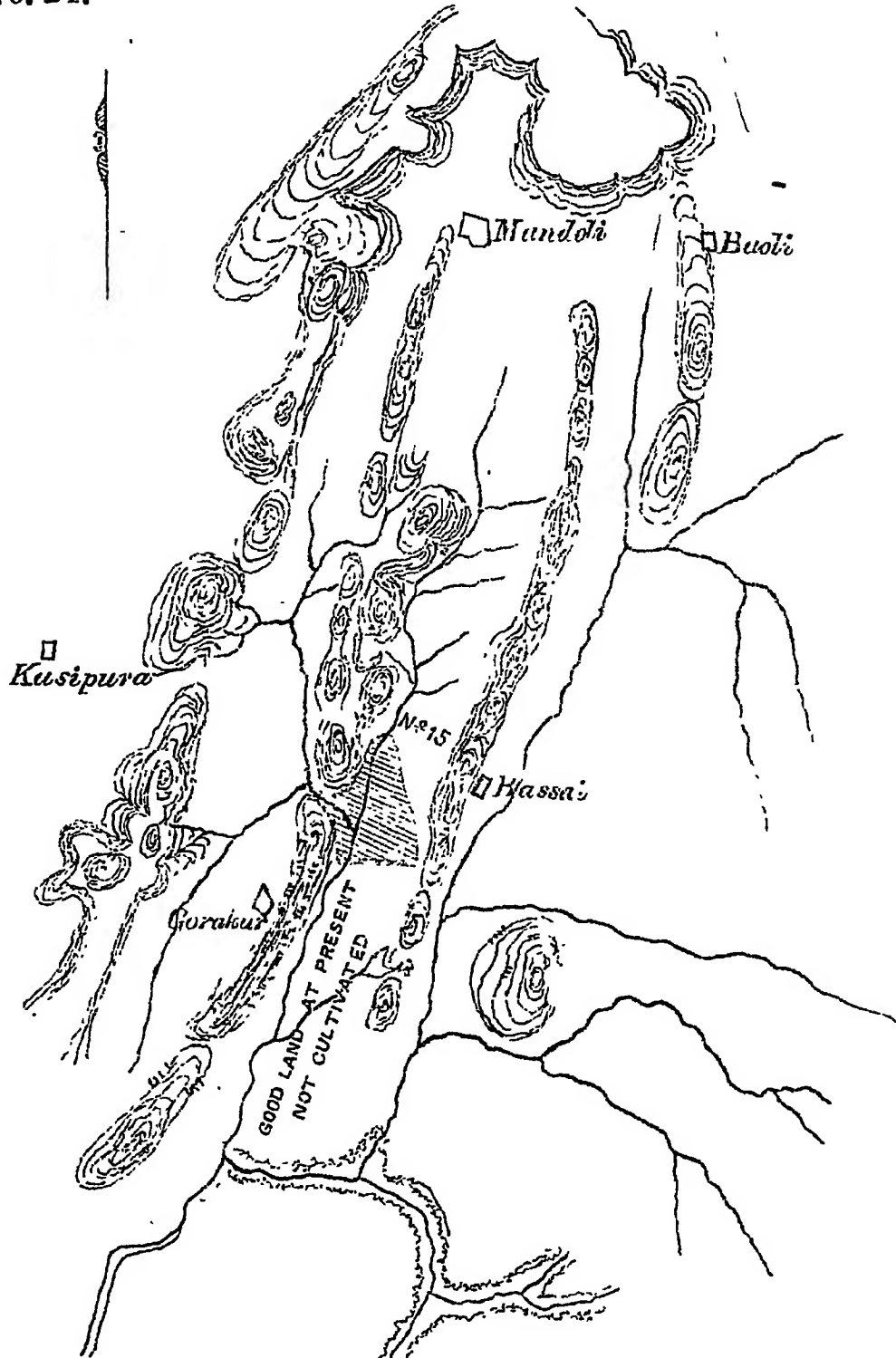
Return, 500 bighas at Rs. 3 per bigha = Rs. 1,500, or 7 per cent.

Survey Sheet No. 42.

SITE No. 14.

SKETCH OF TANK NEAR BASSAI.

No. 21.



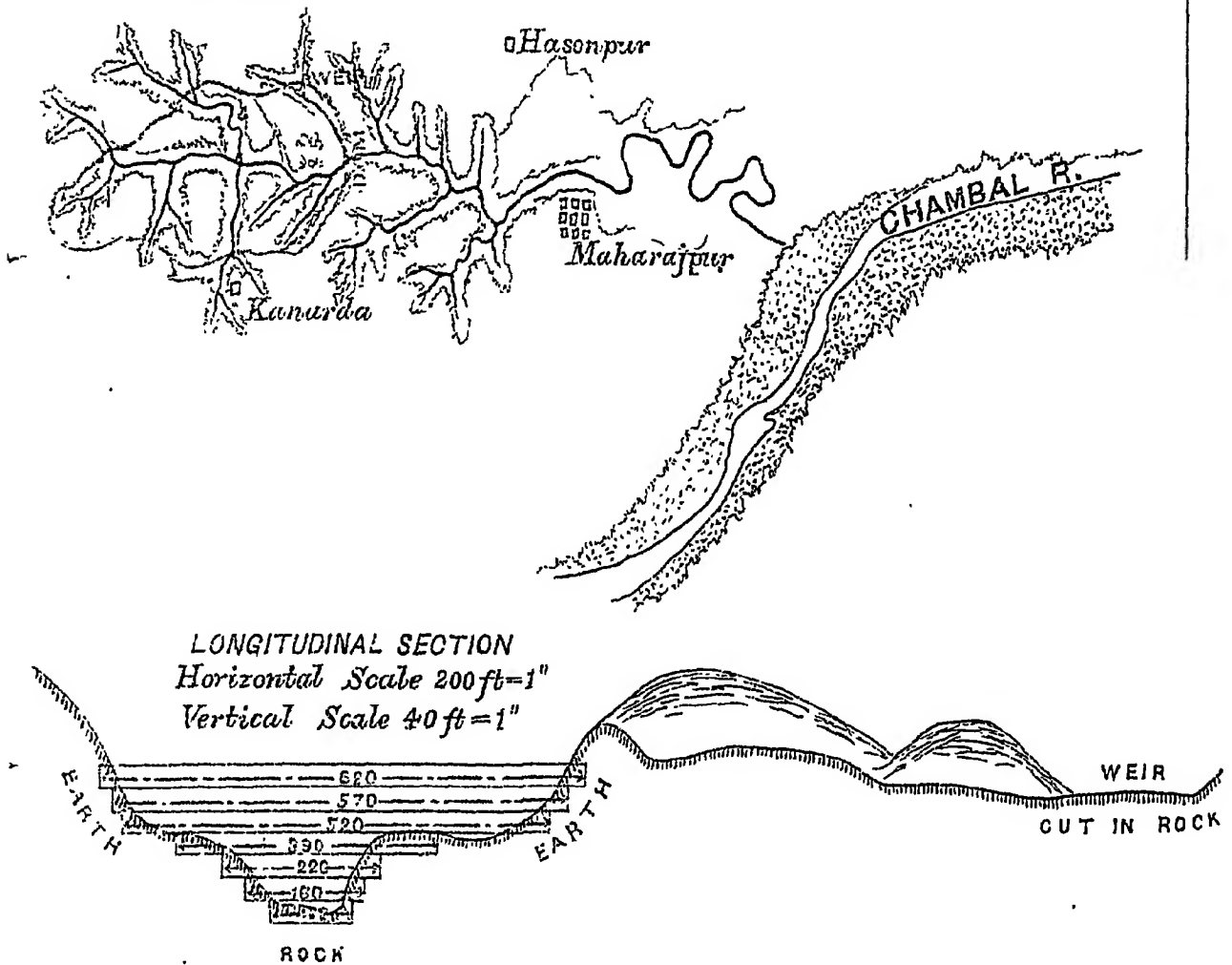
There is a good site for a tank here. I unfortunately have not got a section, but I should say that a fair tank could be made for about Rs. 20,000 capable of irrigating 500 bighas of good land at present lying waste. The catchment area is a large one, over five square miles, and the tank ought consequently to fill well. As no revenue is at present derived from the land which would be commanded by the tank, the increase ought to be $500 \times 4 = \text{Rs. } 2,000$ per annum, or 10 per cent. on the probable cost.

Survey Sheet No. 43.

SITE No. 5.

SKETCH OF KANARODA TANK.

No. 22.



This is a very good site. As the stream is a mountain torrent, and there is rock at no great distance from the surface, it would perhaps be advisable to make the dam of masonry in lime throughout. Type H is therefore, recommended.

Estimate of Cost (Type H).

						Rs.
620 r.ft.	@ Rs.	150	per 100 r.ft.	...	=	930
570	"	450	"	"	...	= 2,465
520	"	750	"	"	...	= 3,900
390	"	1,050	"	"	...	= 4,095
220	"	1,350	"	"	...	= 2,970
160	"	1,350	"	"	...	= 1,650
100	"	1,650	"	"	...	= 1,950
200	"	Weir cut in rock @ Rs. 2 per r.ft.			=	400
1 Discharge Sluice				...	=	500
650 r.ft.	Foundations at Rs. 2 per r.ft.			...	=	1,300
	Contingencies @ Rs. 10 per cent.			...		2,115
Total Cost					...	23,265

or say Rs. 23,300.

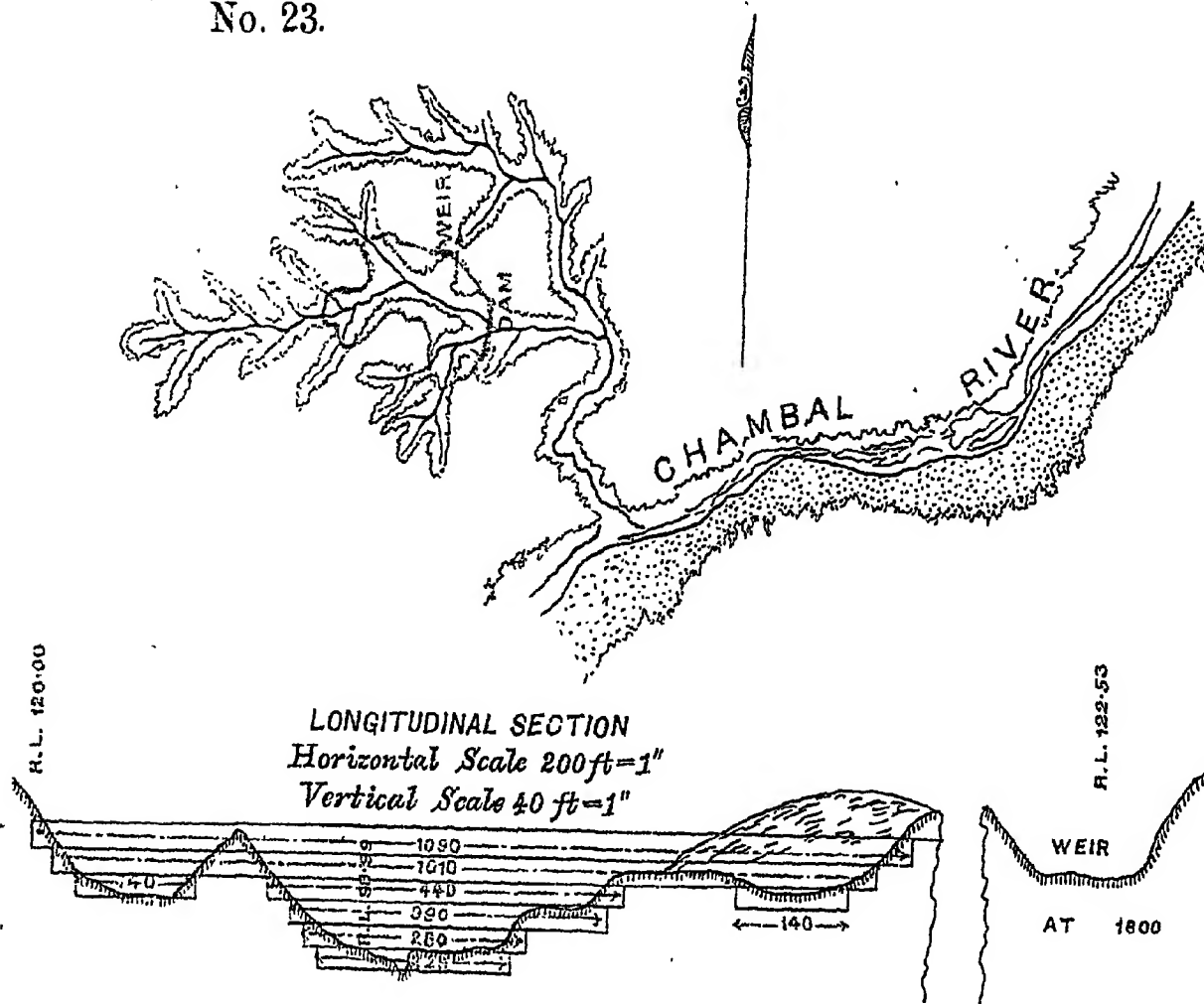
Return, 800 bighas at Rs. 3 = Rs. 2,400, or a little over Rs. 10 per cent.

Survey Sheet No. 43.

SITE No. 7.

SKETCH OF DEOPUR TANK.

No. 23.



A somewhat similar site to the one at Kanurda. Here, however, Type H would not suit as well, and Type L is recommended.

Estimate of Cost (Type L).

							Rs.
1,090	r.ft.	@	Rs. 105	per 100 r.ft.	...	=	1,145
1,010	"	"	395	"	"	...	= 3,990
720	"	"	545	"	"	...	= 3,924
390	"	"	695	"	"	...	= 2,710
280	"	"	845	"	"	...	= 2,366
240	"	"	995	"	"	...	= 2,388
150	"	Weir in rock @	Rs. 2	...	...	=	300
1,200	"	Foundations	"	3	...	=	3,600
Scouring Sluice	...	...	...	...	...	=	1,000
Total							21,423
Contingencies @ Rs. 10 per cent.							2,142
Total Cost							23,565

or say Rs. 23,600.

At least 500 bighas of land will be brought under cultivation in the bed, which at Rs. 3 per bigha should yield a revenue of Rs. 1,500, or 6 per cent. on the contemplated expenditure.

No. VII.

APPENDIX E.

Abstract Statement of New Tanks proposed for Construction,
and of Old Tanks needing Repair.

Abstract Statement of New Tanks proposed for Construction and of Old Tanks needing Repair to accompany report on the initiation of Public Works in the Karauli State.

Topographical Survey Sheet No. 8.

No.	Tank at	Nature of work required.	Estimated Cost. Rs.	CULTURABLE AREA IN BIGHAS.		Estimated increase to annual Revenue.	Percentage of increase to cost.	REMARKS.
				In Bel.	Below Dam.			
1	Darha	Repairs	7,000	100	200	600	8.5	Fair, recommended.
2	Ghajeepur	New Tank	3,800	100	...	200	5½	"
3	Near Darha	"	8,000	...	300	600	7.5	" recommended.
4	Ghajeepur	"	880	...	...	...	...	To prevent damage.
5	Peepalkhera	"	8,000	150	...	300	3.7	
6	Do.	"	1,700	...	...	...	...	Upkeep of present revenue.
		Total	29,380	350	500	1,700	24.95	

Topographical Survey Sheet No 8½.

No.	Tank at	Nature of work required.	Estimated Cost.	CULTURABLE AREA IN BIGHAS.		Estimated increase to annual Revenue.	Percentage of increase to cost.	REMARKS.
				In Bad.	Below Dam.			
1	Meola ...	Repairs ...	200	...	...	...	...	Upkeep of present revenue
2	Chamraola ...	" ...	100	...	...	...	...	" " "
3	Bhojpur ...	New Sluice to Tank	2,000	...	200	600	30 p.c.	Good, recommended.
4	" ...	New Tank ...	7,400	...	200	600	8.1	Fair - "
5	Madanpur ...	New Tank ...	17,600	300	200	1,000	5.7	Fair.
6	Anajara ...	New Tank ...	35,000	500	...	1,500	4.3	Rather low percentage.
7	Malpur Naraina ...	Completion of Tank	31,500	500	...	1,500	4.3	" "
8	Near Machilpur ...	New Tank ...	21,000	...	650	1,300	6.2	Fair.
9	Rundkapura ...	New Tank ...	27,500	...	1,000	3,000	10.9	Recommended, Good.
10	Madan Sagar ...	Sluice and raising weir of present Tank ...	3,000	...	200	600	20 p.c.	" "

X 11	Sohara	...	...	...	...	...	16,300.	...	625	1,875	11.75	Recommended, Good.
12	Bavai	...	...	...	...	...	16,000	...	...	...	...	Land comranded belongs to Gadholi. (See Report.)
13	Baboopoora	...	...	...	...	...	19,500	400	..	1,200	6.2	Fair, recommended.
14	Rudar	...	...	...	...	...	3,800	100	...	300	7.3	"
15	Sohara	...	...	...	...	...	4,400	...	...	...	...	"
16	Golahana	...	...	...	...	...	49,000	...	750	2,250	4.5	For drinking.
X 17	Sohara	...	...	...	...	...	7,500	...	100	300	4	Low, not recommended.
18	Lakimpur	...	...	...	...	...	200	...	...	...	...	Fair, recommended, area rather under-estimated.
19	Lotdha	...	...	...	...	...	9,000	...	300	900	10	Upkeep.
20	Lotdha	...	...	...	...	...	14,800	...	400	1,200	8.1	No. 19 recommended in preference to No. 20. (See Report.)
21	Sillaoti	...	...	...	...	...	500	...	...	..	...	Upkeep.
22	Garhi	...	...	...	...	...	...	...	...	...	...	(See Report.)
Total							...	...	...	...	...

Topographical Survey Sheet No. 10 (a).

No.	Tank at	Nature of work required.	Estimated Cost. Rs.	CULTURABLE AREA IN BIGHAS.			Estimated increase to annual Revenue.	Percentage of increase to cost.	REMARKS.
				In Bed.	Below Dam.				
1	Durgoosi	New Tank	4,50,000	...	5,000	...	20,000	...	See Note.
2	Nindar	"	45,000	...	4,000	...	10,000	22	Good. Detailed estimate already submitted.
3	Markakoa	"	38,500	600	...	...	1,800	4.7	Good. The probable area in bed is under-estimated.
4	Khirk	"	10,700	250	...	...	500	5	Fair.
5	Gopalpur	Repair	250	...	...	...	...	...	Upkeep.
6	Moorla	New Tank	4,300	100	...	...	200	5	Fair.
7	Seapoora	"	19,200	...	500	...	1,500	7.4	Good—recommended.
8	Darroora	"	10,800	...	150	...	450	4.1	Fair.
9	Manakhoor	"	14,750	...	...	...	...	...	Included at the express desire of the villagers.
10	Mohanpura	Masonry Weir	2,250	45	...	...	225	10	Good. (See Note.)
11	Pasala	New Tank	5,000	...	50	...	250	5	Fair.
12	Pasali	"	10,900	...	90	...	450	4.1	Fair.
13	Bherda	Alteration and repairs	1,500	...	...	...	...	...	Upkeep. Rs. 100 being spent on emergent repairs.
14	Matkapura	Renewal	1,700	...	80	...	240	14.1	Completed. Rs. 100 being spent on emergent repairs.
15	Khoobnagar	Repairs	290	...	...	...	30	...	Up keep of present revenue.
16)	Mandraol	Repairs.		...	...	...
17)		Total							

Topographical Survey Sheet No. 10 (b)

No.	Tank at	Nature of work required.	Estimated Cost. Rs.	CULTURABLE AREA IN BIGHAS.		Estimated increase to annual Revenue.	Percentage of increase to cost.	REMARKS.
				In Bed.	Below Dam.			
1	Goosai	New Tank ...	6,000	400	...	1,200	20.0	Good, recommended.
2	Karanpur	" "	10,000	200	...	600	6.0	Fair.
3	Thorali	" "	20,700	300	...	900	4.3	Rather low, not recommended.
4	Sumaral	Repairs ...	800	...	...	..	...	Upkeep.
5	Arora	New Tank ...	30,000	1,000	...	3,000	10.0	Good, recommended.
6	Rudai	To prevent nullahs from cutting.	30,000	550	...	1,650	5½	See Report.
		Total ...						

Topographical Survey Sheet No. 42.

No.	Tank at	Nature of work required.	Estimated Cost. Rs.	CULTURABLE AREA IN BIGHAS.		Estimated increase to annual Revenue.	Percentage of increase to cost.	REMARKS.
				In Bed.	Below Dam.			
1	Dabra ...	New Sluice and Canal	8,500	...	2,000	4,000	47 p.c.	Only if the tank fills and retains water.
2	Gotra ...	New Tank ...	75,000	...	5,000	15,000	20 p.c.	Good. Estimate submitted for sanction.
3	Garain ...	" "	...	...	...	...	...	Will only be required if No. 2 cannot store all the water running off the catchment.
4	Kirkhera ...	" "	7,200	100	...	200	2½	
5	Sairota ...	" "	3,600	300	...	600	16½	Good.
6	" ...	" "	1,150	50	..	100	9	"
7	Mandho ...	" "	6,900	250	...	750	11	Good. The tank is now I hear being constructed by the villagers themselves.
8	Kirkhera ...	Renewal ...	3,000	(not taken out)				
9	Dabra No. 2 ...	New Tank ...	17,000	500	...	1,500	9	

	Sapatra	...	...	...	...	New Tank	...	5,200	100	...	300	5½	
10	Sapatra	...	...	...	...	...	...	...	100	...	300	5½	
11	Amargarh	...	...	...	...	"	"	17,000	1,000	...	3,000	17	Good. Now under construction for the Amargarh Thakoth.
12	Amerwar	...	...	...	...	"	"	14,000	300	...	900	8½	Good.
13	Lohera	...	...	...	...	"	"	21,500	500	...	1,500	7	
14	Basaia	...	...	...	...	"	"	20,000	...	500	2,000	10	Good, recommended.
15	Atagwa	...	...	...	...	"	"	14,500	300	...	900	6½	" "
16	Atagwa	...	...	...	...	"	"	17,500	...	500	1,500	8½	" "
17	Thom Tank...	...	...	...	...	"	"	...	...	...	...	...	See Report.
18	Jakhoda	...	...	...	...	.....	.....	...	...	...	..	...	See Report.
						Total	...						

Topographical Survey Sheet No. 43.

No.	Tank at	Nature of work required.	Estimated Cost. Rs.	CULTURABLE AREA IN BIGHAS.		Estimated increase to annual Revenue.	Percentage of increase to cons.	REMARKS.
				In Bed.	Below Dam.			
1	Nynie Goari	New Tank	21,000	..	700	1,800	8 7	Now nearly ready with the exception of duct which has not yet been sanctioned.
2	Maidpura	Renewal	2,000	..	..	..	..	Upkeep and probable increase.
3	Daulatpur	"	5,600	..	..	..	..	Upkeep (See Report).
4	Chondka (bara)	New Tank	3,000	..	50	150	5	A better site can probably be found.
5	Kanarda	"	23,300	800	..	2,400	10 p.c.	Good (See also Report).
6	Gota	"	4,700	200	..	600	12 3/4	Not recommended, as a permanent dam cannot be made here.
7	Deopur	"	23,600	500	..	1,500	6	Good, recommended.
8	Nandpur	Repair	4,000	..	250	500	12 1/2	"
		Total	..					

No. VIII.

Letter No. 1805-S, dated 29th June 1885, from the Secretary to the Hon'ble the Agent to the Governor-General in Rajputana P.W.D., to the Political Agent, Bharatpur.

WITH

(a)—Note on Nindar Tank Project.

(b)—Note on Gotra Tank Project.

Copy of a Letter No. 1805-S, dated 29th June 1885, from the Secretary to the Agent to the Governor-General, Rajputana, in the P. W. D., to the Political Agent, Bharatpur and Karauli.

I. I have been directed by the Agent to the Governor-General to return to you for transmission to Mr. Housden, Executive Engineer, Karauli, the plans and estimates prepared by him for the proposed Tanks at Nindar and Gotra, together with a copy of the Notes made on each by the Officiating Superintending Engineer.

II. Should the Karauli Durbar require the Executive Engineer to prepare projects for other Tanks, or to revise those now returned, the Agent to the Governor-General considers it desirable that he be guided, as far as the circumstances of each case will admit, by the Notes in question.

Note by A. B. Gatherer, Offg. Superintending Engineer, Rajputana, on the Nindar and Gotra Tank Projects, Karauli State, submitted by Mr. C. E. Housden, Executive Engineer.

I. These projects have been forwarded to me by the Agent Governor-General for examination and scrutiny, and for an expression of opinion on the schemes proposed.

II. **Nindar Tank.**—The site selected for the work appears a good one, and possesses the great advantage of having the waste weir entirely separated from the main bund, so that all risk of the waste water cutting round to the toe of the rear slope of the bund is avoided. The site also appears to be the most economical, advantage having been taken of an earthen ridge running across the valley.

III. The catchment area of the tank is taken at 17 square miles. The average rainfall for the last 5 years has been 28.37 inches, and has ranged from 19 to 40 inches. Mr. Housden has assumed an average rainfall of 27 inches. He assumes that $\frac{1}{3}$ of this, or 9 inches, will be available for storage.

This I consider to be too sanguine an estimate of the available rainfall. In the Mysore Province, where I have had considerable experience in Tank Irrigation, we could not depend on a run off of more than 6 inches for storage, where the average rainfall was found to be 33 inches. Much of course depends on the nature of the catchment ground; yet, assuming it to be favourable in the present instance, I do not consider it safe to calculate on a greater run off for storage than 6 inches. Experience has shown in Mysore that only $\frac{2}{3}$ of the *amount stored* can be depended on for irrigation. This provides for loss of all kinds. Accepting this data we have in the case of the Nindar Tank an available supply of $14 \times 17 = 238$ m.c.ft., of which 159 million are actually available for cultivation. The tank should be capable of holding 238 million.

IV. The design as submitted by the Executive Engineer gives a depth of 20 feet between the level of the lowest sluice and that of the waste weir. From contours taken the capacity of the tank between these two levels has been ascertained to be 371 million. It is, therefore, sufficiently large for all our requirements. It may be argued that it has been shown that we can only depend on securing 238 million, while we go to the expense of providing storage for 371 million; the error, if an error, is on the safe side, and I would not recommend any reduction being made in the size of the tank, but leave it as proposed by the Executive Engineer.

V. In Mysore the water stored in tanks was, as a rule, utilised for the full irrigation of rice and 270,000 c.ft. was required per acre. Rice in most part of the Karauli State is important, and, in the absence of information to the contrary, assuming that rice will be the crop below the Nindar Tank, we will, allowing 270,000 c.ft. per acre, have a supply of water sufficient to irrigate $\frac{1,590,000,000}{270,000} = 588$ acres.

It is stated in Mr. Housden's report that 12,000 bighas or 4,000 acres are commanded; we need, therefore, have no doubt but that there is the land available to the extent to which we can supply water.

VI. Taking an acre as 3 bighas we will have water for 1,764 bighas. In the Revenue Statement, Appendix F, it is shown that 7,968 bighas are situated below the tank and that the present revenue derived from these is Rs. 9,949, or Rs. 1-4 per bigha. The Executive Engineer states that the rate realised at Dhoneta, one of the villages below site of proposed tank, is given as Rs. 5-7 per bigha, and he considers that an additional assessment of Rs. 3 per bigha is not excessive and can be depended on. The Political Agent, Karauli State, in his letter (para. 7) No. 388-G of 2nd June 1885, forwarding the project remarks: "It must again be repeated that the data and figures on which the proposed estimates of profit have been calculated, have been carefully checked and found to be moderate and trustworthy by competent Native Revenue authorities and by the members of the Council."

In para. 8 of the same letter the Political Agent remarks, "that the Zamindars of Mandrail village have already offered to take up the whole of the land where irrigated at from Rs. 2½ to Rs. 2 a bigha." Assuming that the rate of Rs. 3, anticipated by the Executive Engineer, is realised, we would have on 1,764 bighas an increase of revenue of Rs. 5,292, but the Executive Engineer, in Appendix E, reported that the anticipated loss of revenue by lands submerged in bed of tank will be Rs. 1,000, so that we can only depend on an increase of Rs. 4,292. The Executive Engineer's estimate of the work amounts to Rs. 44,347, or say Rs. 45,000. Assuming that it will cost this sum, the anticipated return would be 9.54 per cent.

VII. Regarding the designs submitted, I would make the following observations:—

Bund.—This is designed to have a top width of 20 feet with front slope of 3 to 1 pitched, and rear slope 2 to 1. I would reduce the top width to 10 feet, adhering to the 3 to 1 pitched front slope, but increasing the rear slope to 2½ to 1. A centre wall of masonry with concrete foundations is allowed at a cost of Rs. 17,190. If good puddle is available I would have no masonry in the work at all. The puddle wall to have a top width (at waste weir level) of 6 feet and carried down to nullah or ground level with a batter of 1 in 12. The foundations for this puddle wall to be carried down to impervious soil, and at that depth need not have a width exceeding 5 feet. I observe a rate of Rs. 4 is allowed for 1,000 cubic feet of earthwork. The rate is low for good work. No information is given as to how the work is to be carried out. If merely thrown up anyhow the above rate would no doubt be ample, but I would strongly deprecate any such method being adopted. Rather give an increased rate for the earthwork and secure really good work; it will pay in the long run. The earthwork should be thrown up in layers not exceeding 9 inches in thickness and each layer well watered and tamped.

VIII. No details are given of the sluices, but an allowance of Rs. 1,000 has been made for cast-iron pipes for each sluice. In Appendix D. the length of the pipes are taken at 12 ft. This would appear far below the required length, seeing the sluices are to be built at a depth of

15 and 20 feet respectively below waste weir level. I would have these pipes laid in a masonry tunnel throughout, with front and rear cisterns. In designing the arch for tunnel—collars should be provided at intervals, and in the construction of the work the outer face should be left unplastered and as rough as possible, in order to reduce to a minimum the chances of a creep along the outside of the masonry. These suggestions will add to the estimate, but would be more than covered by the saving effected in substituting a puddle wall for the masonry as now estimated for.

IX. A good site has been secured for the weir. The work is estimated to cost Rs. 2,015 only, while a length of 400 feet has been secured.

No information is given that this length will meet the requirements of the tank.

The run off over the whole catchment area of 17 sq. miles may be taken as not exceeding $\frac{3}{4}$ inch per hour. Assuming the weir to run 2 feet in depth and that the waterspread in the tank at that level is the same as at weir level, by the formula $L = 0.72 \left\{ \frac{2}{5} \frac{A\alpha}{h^{\frac{3}{2}}} - \frac{S}{h^{\frac{1}{2}}} \right\}$ where L = required length of weir in feet A = area of catchment in acres, α = maximum run off in inches per hour, S = mean area in acres between waterspread at high flood level and at waste weir level, h = height in feet of water going over weir.

$$\text{We have } L = 0.72 \left\{ \frac{2}{5} \frac{17 \times 640 \times \frac{3}{4}}{2^{\frac{3}{2}}} - \frac{773}{2^{\frac{1}{2}}} \right\} \therefore L = 439 \text{ feet.}$$

As the weir can run over safely surplus to a depth of $2\frac{1}{2}$ feet, the length allowed by Executive Engineer of 400 feet will suffice.

X. The provision made for the distribution channels appears ample. These works call for no special remarks. They have been approximately estimated to cost Rs. 5,000.

XI. Mr. Housden deserves great credit for the manner in which he has prepared the requisite Plans and Estimates, and also for the thorough investigations he appears to have made in connection with the project. It will be seen that the whole question of the construction of the work depends on the financial results. I should have been glad had my investigation of the project produced the favorable return anticipated by the Executive Engineer. While admitting that I have no knowledge of the country in which it is proposed to construct the work, and that the data I have used has been based on experience gained in another part of India, I cannot help thinking he has taken too favorable a view of the available rainfall. It must not for a moment be imagined that I wish to throw cold water on the scheme, but the reverse; for I believe it to be a sound irrigation project and deserving of all consideration. While my estimated return of 9.50 per cent. is small, it can, I am convinced, be depended on. Were the project recast on the lines suggested by me, it will probably be found that a considerable saving on the original outlay can be effected, and consequently greater returns obtained, while the work will be equally as effective and secure.

NOTE ON GOTRA TANK.

I. I wish this Note read along with my Note on the Nindar Tank. In examining this project I have used the same data as that in my examination of the Nindar project, so that I need not repeat my reasons for using this data.

II. The site selected for the Gotra Tank appears an excellent one and in every respect desirable. It has been arranged to have the waste weir away from both the bunds.

III. The catchment area is given as 20 square miles and rainfall 27 inches. We can depend on a run off available for storage of 280 million c.ft. To this we may safely add the 126 million obtained from the perennial stream alluded to by the Executive Engineer. Total amount for storage is therefore 406 million. Of this $\frac{2}{3}$, or 270 million, are available for cultivation, or sufficient for 1,000 acres or 3,000 bighas of rice. Taking the increase in revenue at Rs. 3, that stated by the Political Agent per bigha, we will have an increase of revenue of Rs. 9,000. This on the proposed outlay of Rs. 74,000, would give 12.15 per cent. Nothing is said by the Executive Engineer regarding the loss of revenue consequent on the bed of the tank being submerged, so I have assumed that the bed is uncultivated.

IV. The above percentage of return will be considerably increased by altering the design for both bunds A and B, in accordance with my suggestions for the Nindar Tank. I would do away with the masonry and substitute an earthen bund with puddle wall. These to be of dimensions similar to those recommended for the Nindar Tank. I wish it to be borne in mind that I recommend these sections on the understanding that the earthwork is to be properly constructed. If this be done there need be no fear of the work, nor any necessity for going to the great expense of the masonry walls as now designed.

V. My remarks regarding the sluices and distribution channels for the Nindar Tank apply equally to the Gotra Tank.

VI. A length of 200 feet is allowed for the waste weir. I would allow for a run off of $\frac{3}{4}$ inch per hour. Then with a depth of 3 feet over weir we require (see formula para. 9 of Note on Nindar Tank) 280 feet. Better therefore have the weir 300 feet in length. It will not cost much.

VII. Equal care and attention appears to have been bestowed by Mr. Housden in the preparation of this project as in the case of the Nindar Tank.

VIII. As far as I can judge from the papers and information furnished by the Executive Engineer, I consider this an excellent irrigation work, and would recommend it for favourable consideration.

No. IX.

Memorandum by Major W. G. Cumming, R.E., Superintending Engineer, Rajputana, of Public Works in Karauli, dated 3rd February 1886.

WITH

(a)—Note on Gotra Tank Project.

(b)—Note on Nindar Tank Project.

Memorandum by Major W. G. Cumming, R.E., Superintending Engineer, Rajputana, of Public Works in Karauli.

I paid a hurried visit to Karauli between the 3rd and 14th of January in company with Mr. C. E. Housden, Executive Engineer of that State, and was able to inspect most of the Public Works carried out by that officer during his year's incumbency, as well as the sites for others proposed, but not yet executed from want of funds.

Before reporting in detail on the works inspected, I desire to place on record the opinion that of all the Native States yet seen by me, Karauli offers the best scope for improvement by means of Public Works judiciously planned and judiciously carried out, and that if funds were only available, a few years' work under Mr. Housden's supervision would effect a vast improvement in the welfare of this interesting territory. Excellent sites are available throughout for the formation of tanks on a large scale, land which is now comparatively useless for want of water, is to be had in abundance below those sites, and notwithstanding the scantiness of the population, it is more than probable that irrigation works on a large scale would attract labour from other less favoured localities. The wants of the State may be summed up under the heads of "Communication and Irrigation Works," and although a good beginning has been made under both these items, it is evident that much more must be done if the natural sources of the country are to be developed according to advanced modern ideas. Mr. Housden has travelled over most of the State and has framed a programme, accompanied by approximate estimates of cost, for its improvement by means of useful public works. This he has embodied in an admirable memorandum, which should, I think, be printed for information and future guidance. I understand that shortness of funds is the chief and indeed the only hindrance to the execution of useful and remunerative public works in Karauli; but as the State will soon be clear of debt it is a question for consideration whether money should not be borrowed either now or then, to inaugurate a scheme for the prosecution of works of the kind, for if these be carefully planned and carefully selected in the first instance, there is every probability of their paying a handsome revenue over and above interest charges.

I hope that something of the kind will be done soon, in order that full employment may be found for Mr. Housden, whose interest in all that concerns the welfare of the State is undoubted. At present about half-a-lakh of rupees only are available for expenditure on public works year by year, and this is hardly sufficient to warrant the continued entertainment of an Executive Engineer and his staff of office and out-door assistants. By borrowing a couple of lakhs from Government and spreading its expenditure over two or three years, much useful work could be carried out, which, if it did nothing else, would at least show whether new irrigation works could or could not be carried out with advantage both to the State and to the people. Judging from my experience of Ajmer and Merwara, where almost all available sites have already been utilised for the formation of tanks, and where it is extremely difficult to find room

for new works of a remunerative nature, I went to Karauli somewhat prejudiced against the expenditure of public money on irrigation works; but judging from the handsome returns obtained from such works in the neighbouring State of Jaipur, constructed on similar soil and under similar conditions as to rainfall and climate, I have come back with altogether different ideas, and am strongly of opinion that Karauli as a whole offers an equally good field for the prosecution of remunerative public works. It has, moreover, this advantage over Jaipur, that in a public works point of view it is, comparatively speaking, virgin country in which no difficulty whatever will be experienced in selecting advantageous sites for useful and paying irrigation projects. I hope, therefore, that arrangements will soon be made for borrowing on the limited scale suggested, the more so as Karauli has lately been connected with the Railway by means of a first-class metalled road which offers facilities hitherto unknown for the easy transport of surplus produce.

Irrigation Tanks and Sluices.—A large masonry sluice has been added to the Dabra Tank at an outlay of Rs. 1,787, and two small sluices to the Mahmoodpur Bund costing Rs. 166 each.

Amergarh Tank, estimated cost Rs. 16,927.—This is an original work well advanced towards completion. The dam consists of an earthen bund 8 ft. wide at top, with side slopes of 3 to 1 stoned-pitched on the water face, and 2 to 1 on the rear face, hearted with a masonry core-wall resting on solid ground, one foot wide at top with batters of 1 in 20 on both sides, and carried up to 5 ft. above weir level. The dam is 371 ft. long, with maximum height of 49 ft. and will form a tank, when full, of an area of about a square mile. Cultivation will be carried out in the bed after the water is drained off, and it is expected that a thousand bighas of ground will ultimately be brought under the plough, returning a revenue of Rs. 3,000 per annum, or 17½ per cent, on initial cost. The waste weir and discharge sluice are quite distinct from the dam—a very necessary precaution in works of the kind. It may be here noted that irrigation works of this kind are usually not so remunerative as those which store water for the purpose of cultivating ground below, but if this work realises anything like the revenue anticipated, after a few years the outlay on it will have been well spent.

Nainca Goari Tank.—This was commenced and nearly completed by Overseer Abdool Majid, and has cost, according to the original estimate, Rs. 19,795.

In June 1885 the face-wall, which was weak, fell in partially; and measures are now being taken to remedy the defect by turning the remainder of the face-wall into a core-wall; by enlarging the weir; and by supplying more sluices, at an estimated additional cost of Rs. 3,000. The area commanded by the tank is 500 bighas only, from which an ultimate revenue of 5 per cent. is anticipated, but the tank will be able to store 47,000,000 cubic feet of water, sufficient to irrigate more than double the area available. The bund was badly designed and badly placed in the first instance. Had it been put higher up the valley it

would have commanded more land, and all available water would have been utilised. This tends to show how necessary it is to have an Engineer of experience to initiate and carry out works of the kind, and how, from want of such knowledge, money may be wasted with the best intentions.

Irrigation works projected but not begun.—Mr. Housden, in his memorandum already alluded to, has reported on a number of sites for the formation of tanks which are likely to pay, and has submitted complete Plans and Estimates for two, viz., the Gotra and the Nindar Tank projects.

During my short tour I was able to thoroughly examine the site for the proposed tank at Gotra, and have come back most favourably impressed with it. Nothing could well be better. A narrow gorge shut in by hills on two sides, by rising ground on the third, and with abundance of land below waiting for water, are its chief characteristics. The only point on which I am at all doubtful is the revenue likely to be derived. Land, as I said before, is there in abundance, but the question is whether the people will bring it under cultivation—in other words whether they will take water at the State rates. This is a point on which the Executive Engineer has promised me further information, and as soon as that has been received I shall be in a position to criticise the project which is being kept back for that purpose. I was unfortunately unable to examine the site of the proposed Nindar Tank, but Mr. Housden assures me that it is equally as good as the one at Gotra, and that the catchment area is even more impervious to soakage. Under these circumstances the tank is likely to prove an Engineering success, but, before reporting on it also, I should like more detailed information as to its probably paying prospects.

The Gotra scheme, as being nearer to Karauli, should be the first one carried out when approved and funds are available. It is estimated to cost Rs. 88,000, and that together with the bridge over the Panchna River and minor works and repairs generally, would be sufficient to keep the Engineer establishment fully employed for another year at least; other works can afterwards be taken up as funds become available. Having made the Gotra Tank, it would perhaps be wise to wait for a year or two to ascertain its financial bearings. Meanwhile money could be advantageously spent in opening up the country by means of improved communications.

Concluding Remarks.—I was much pleased with all that I saw during my inspection. Mr. Housden takes a thorough interest in his work and in all that relates to the welfare of the State. His withdrawal to the Public Works Department of Government would, therefore, be a real loss, not only to the Durbar but to the people generally. I trust, therefore, that some means may be found for retaining his services at Karauli for a few years more, either as the Engineer of the State or as the Joint Engineer of two or more States, under Colonel Evan Smith's Political charge.

Dated 3rd February 1886.

No. IX (*a*).

NOTE ON GOTRA TANK PROJECT

BY

Major W. G. Cumming, R.E., Superintending Engineer,
Rajputana.

Note by Major W. G. Cumming, R.E., Superintending Engineer, Rajputana, on the Gotra Tank Project, Karauli State.

This is one of the two large irrigation projects which Mr. Housden, during his year's residence at Karauli, has prepared for the approval and sanction of the A. G.-G. The other is the Nindar project, on which a separate Note will be written later on.

The original project for the Gotra Tank was submitted to the Local Administration for consideration and orders in June last. It was returned to the Political Agent for revision, in accordance with the suggestions contained in Mr. Gatherer's exhaustive Note of the 19th idem, and having been so revised, is now re-submitted for final orders with Colonel Euan Smith's letter No. 772-G, on the 25th of August last. It is explained that money is not immediately available from surplus revenue to commence the work, but that the project is sent up for professional criticism and for sanction to its execution, as soon as arrangements can be made to supply the necessary funds.

The revised project has also had the advantage of Mr. Gatherer's criticism as contained in his short Note of the 3rd of October last. He therein expresses his general approval of it, but recommends, at the suggestion of the Executive Engineer, that the shorter of the two bunds—the one marked A on the Index Map—be constructed of masonry in lieu of earth. Time being of no object, I have kept back the project until I was able to inspect the site and clear up some points which struck me as doubtful in the absence of local knowledge. This I have now done, and am glad to find that the project is more hopeful in every way than I was led to anticipate from a perusal of the previous papers and Notes thereon. From a general point of view nothing could well be better than the site selected. It is within a day's journey of Karauli.

The work can therefore, as the first of a proposed series of large tanks of the kind, be carefully supervised while under construction, and fostered and safe-guarded afterwards to make it pay. These are matters of considerable importance in a comparatively poor State, when the prosecution of an extensive system of tank irrigation must depend in a great measure on financial results, gained by actual experience from those works first constructed.

Leading Features of the Project.—From an Engineering point of view the site is all that can be desired. The greater portion of the catchment area is shut in by hills on two sides, between which "the Oogla," a small perennial stream flows, ultimately forcing its way through a narrow gorge in the hills a mile to the west of the village of Gotra.

By bunding up this gorge and by constructing a larger and supplementary bund across the valley a little lower down, a large tank can readily be formed. These are the leading features of the scheme.

Particulars will now be noticed.

Bunds.—The sites selected for these are, I think, appropriate.

That for the larger one, 1,800 ft. long might be shifted at its western extremity a hundred feet or so up the valley, to enable the bund to run in a straight line from one end to the other.

As designed, the alignment is slightly concave towards the water side, and is consequently weaker than it need be. The section proposed is good. It provides for a top width of 10 feet with side slopes of 3 to 1, stone pitched on the water face and $2\frac{1}{2}$ to 1 on the rear face.

Alternative proposals are made for hearting the bund with a masonry or a clay core-wall. Masonry should certainly be used in my opinion. Good clay is not available near the spot, and to put in indifferent material of the kind would only court disaster. The smaller bund, 280 feet long, closing up the gorge should be constructed entirely of masonry. Here the full impact of the Oogli stream is felt, and measures should be taken to make the work strong and durable. The nature of the ground, moreover, is unsuited to closure with earth, and stone and lime are to be had in abundance on the spot. A proper design and estimate for this portion of the work, based on scientific principles, should be submitted for sanction: being 45 feet at its maximum height, the bund must be strongly designed and well built.

Waste Weir.—This is situated about 600 feet to the north of the smaller dam and will be cut out of the solid hill side. Its proposed width of 280 feet is correct according to calculation, to allow of a rainfall of $\frac{3}{4}$ of an inch per hour passing over it 3 feet deep.

Sluices.—These are two in number of simple and appropriate design. They are similar to those lately added to several old tanks in Karauli and are found suitable to the requirements of the people. They take off at R. L. 110 and 120 feet respectively for the smaller and larger dams, and are well placed, as the ducts leading from them will command most of the ground in the vicinity.

Capacity of Tank, Catchment Area and Run-off.—The cubical contents of the tank, when full to weir level, are estimated at 382½ million cubic feet. This is correct for all approximate purposes. To feed the tank there is, in addition to the Oogli perennial stream, a drainage area of 20 square miles. The latter with an assumed run-off of 6 inches of rainfall gives 280 m. c. ft., and the former with an observed discharge of 4 feet per second 126 m. c. ft.; in all 406 m. c. ft. This at first sight would lead to the supposition that the tank, as designed, is hardly large enough to hold the anticipated supply. But it must be remembered that the assumed run-off of 6 inches over the catchment area is large, though perhaps not excessive, judging by results elsewhere in Karauli, and that a considerable portion of "the Oogli" supply should in reality be included in that already anticipated from the general catchment area; under these circumstances it is probable that the tank as

designed will be sufficient for the purpose. Should that, however, not be the case, a supplementary tank can readily be constructed later on higher up the valley, near the village of Garain.

Balance of water likely to be available for Cultivation.—It has been shown that 406 m. c.ft. of water may find its way into the tank. Mr. Housden allows half of this for evaporation, soakage and unaccountable wastage, and arrives at the conclusion that 203 m. c.ft. per annum will be available for actual cultivation. This in my opinion is under the mark, but for purposes of calculation it may be allowed to stand. There are then 203 m. c.ft. of water for actual cultivation, which at a water duty of 90,000 c.ft. per acre gives sufficient for 2,225 acres or 6,765 bighas of land. These deductions are, I think, reasonable, and may be accepted in the absence of more exact data.

Net returns likely to be realised.—This is the last and most important item of the scheme. If it were absolutely certain that all available water would be readily taken up, a revenue of at least Rs. 13,000 per annum would be realised after a few years, by a combined land and water rate of Rs. 2 per bigha. Land is there in abundance waiting for water; I saw that myself. But the question is, will the people agree to pay Rs. 2 a bigha for it? Col. E. Smith and the State Council appear to have no doubt on the subject, and they are the best judges. But from all that I could gather on the spot, it seemed to me that though the people were anxious to get the water, native like, they were inclined to haggle over the price. I asked Mr. Housden to get me more definite information on the subject, but on further consideration am inclined to think that this is hardly necessary. It must be remembered that this, the first work of the kind, will be an experimental one. Should it pay a fair return over and above interest charges, it will point the way to other similar works. Should it prove financially unsuccessful no great harm will be done.

Mr. Housden estimates that the scheme will pay $14\frac{3}{4}$ per cent. on capital outlay. I understand that some of Col. Jacob's tanks in Jaipur territory pay more than that.

As an experimental measure I would be satisfied with anything over 8 per cent., and that I think may be reasonably expected.

Concluding Remarks.—I recommend, therefore, that the project be sanctioned for execution, subject to the modifications suggested in this Note, as soon as funds are available. The total cost should not exceed Rs. 90,000 as funds in any case will be limited for some years to come. I also recommend that this should be the first irrigation work to be put in hand and completed, and that its financial results be carefully ascertained by the test of time before similar works elsewhere are taken up. If this suggestion be approved, the Nindar project, though approved and sanctioned, should be postponed for a year or two.

13th February 1886.

No. IX (*b*).

NOTE ON THE NINDAR TANK PROJECT

BY

Major W. G. Cumming, R.E., Superintending Engineer,
Rajputana.

Note by Major W. G. Cumming, R.E., Superintending Engineer, Rajputana, on the Nindar Tank Project, Karauli State.

This project was submitted by the Political Agent in June last, and having been revised and recast in conformity with Mr. Gatherer's instructions, as contained in his full and clear Note of the 19th idem, is now re-submitted for further professional criticism and final sanction.

I regret that while at Karauli I was unable to see the site for this tank, but having carefully examined the site for the Gotra Tank, and having had frequent conversations with Mr. Housden in regard to the nature of the soil at Nindar, I am in a position to report on the merits of the scheme more fully than I was before I paid my visit to Karauli.

From all that I could gather, it appears that the catchment area of this tank project is more rocky and consequently more favourable than that of the Gotra scheme, and that abundance of land suitable for wet cultivation is to be found in the vicinity which will be readily taken up and cultivated as soon as water is supplied. On these points, therefore, no difficulty need be raised at this stage of the question.

The project is not dissimilar to that already reported on the Gotra Tank, for the same data and the same modes of construction have been adopted for both. These have all met with Mr. Gatherer's approval and meet with mine. The only matter on which I am at all doubtful is the puddle core-walling allowed for the main bund. At Gotra I saw no clay suitable for the purpose, and though it may exist here, the point should be definitely settled before work is put in hand, for if the clay be inferior or found mixed with stones and sand, it should be rejected and masonry used instead. The extra cost will be economy in the long run. The tank will be formed by constructing an earthen bund, 1,800 feet in extreme length and 30 feet maximum height, across the valley near the village of Nindar, to cut off the Nindar Nullah which here flows through a ridge, and by constructing a small supplementary protective bund opposite the village of Nindar. The capacity of the tank so formed is estimated at 379 m. c.ft. The catchment area is 17 square miles, and allowing for a run-off of 6 inches the quantity of water coming into the tank should be 238 m. c.ft. As designed, therefore, the tank is amply sufficient for all the water expected. The waste weir, which is separate from the main bund, of stone and lime, is designed to be 430 feet long. This is correct according to calculation. Bunds, weirs, sluices and ducts are similar to those noted on for the Gotra project and meet with my approval. Deducting 12 m. c. ft. as being below the lowest sluice level, the water stored will amount to 226 m. c. ft. Of this Mr. Housden deducts one half for wastage, leaving 113 m. ft. available for actual cultivation. This at a water duty of 90,000 c. ft. per acre, or 30,000 c. f. per bigha, would be sufficient for 3,700 bighas, which, at an assumed rate of Rs. 2 per bigha, gives an annual revenue of Rs. 7,400. But after deducting for anticipated loss consequent on land submerged, the net return

would only amount to Rs. 6,000, or 15 per cent. per annum on an estimated initial cost of Rs. 40,000. It is explained that more than three times this area is available for cultivation; consequently no difficulty should be experienced in utilising all water stored, provided the people agree to pay the State price for it. This it is said they are prepared to do.

The project in my opinion has very much to commend it. I recommend, therefore, that it be sanctioned, subject to the suggestion contained in regard to the core-walling. The work to be taken in hand after the Gotra Tank has been constructed and its financial results gauged.

No. X.

Letter No. 2316, dated 14th March 1901, from Mr. J. A. Devenish, Executive Engineer, Bharatpur State, to the Political Agent, Eastern States, Rajputana.

Copy of a letter No. 2316, dated 14th March 1901, from Mr. J. A. Devenish, Executive Engineer, Bharatpur State, to the Political Agent, Eastern States, Rajputana, Bharatpur.

1. In compliance with your letter No. 814 of the 13th ultimo, I have the honor to submit, for the information of the Agent to the Governor-General, the required information concerning the Irrigation Projects for the Karauli State, which were proposed by Mr. C. E. Housden during his deputation for that purpose in 1885-1886 A.D. In accordance with instructions, I have abstracted the information from Mr. Housden's note-books (herewith forwarded).

2. These note-books were retained and brought from the Karauli State by an Overseer named Alla Buksh, who was formerly employed by Mr. Housden, and this means of information, which I brought to the notice of the Political Agent, has been supplemented by files (herewith returned) of estimates and reports concerning the Karauli Public Works, which were deposited in the Agency Office of Bharatpur.

No other papers or plans bearing upon the question have yet been placed at my disposal. Alla Buksh, who is now employed in the Bharatpur State, informs me that other plans and papers which were handed over to him in transfer by Mr. Housden, are deposited in the Revenue Office of the Karauli State.

3. The note-books have now been abstracted by me in a statement herewith submitted entitled, "A descriptive list of Irrigation Projects proposed for the Karauli State, Rajputana, by Mr. C. E. Housden."

This statement displays the several projects in serial order, the estimated cost of each, the areas assumed to be irrigable, the estimated revenue derivable and the estimated percentage of direct return from each, together with the explanatory remarks recorded in the note-books.

4. Mr. Housden's note-books have been so carefully prepared that they enable the whole of the work done by him during his service in the Karauli State to be traced. In them reference is made to certain sheets of the published map and to plans of certain projects prepared in detail. Office copies of the reports referred to in the note-books were found in the Agency Office at Bharatpur, and have been placed at my disposal; and it is probable that all the plans and maps referred to can be found after further search.

5. Copies of sheets Nos. 8, 8½, 10a, 10b, 42 and 43 of the published 1" = 1 mile map of the Karauli State are herewith submitted, on which the sites noted by Mr. Housden have been marked in my office. The catchment areas have been calculated and a note made of each in the descriptive list.

6. All the information called for in the Political Agent's No. 884 of the 13th ultimo has thus been obtained and summarised in the list herewith submitted.

7. It may be seen that some eighty sites were examined or noted by Mr. Housden.

From a scrutiny of the list it may be observed that suggestions are made for one very large project (serial No. 64) estimated to cost Rs. 4,50,000; also for one project approximately estimated at Rs. 75,000; two between Rs. 40,000 and Rs. 50,000; five between Rs. 30,000 and Rs. 40,000; seven between Rs. 20,000 and Rs. 30,000; sixteen between Rs. 10,000 and Rs. 20,000; nine between Rs. 5,000 and Rs. 10,000, and the remainder below Rs. 5,000. The sum total of the estimates quoted, amounts to about 8½ lakhs, excluding the very large project No. 64. The catchment areas are generally small, there being only one noted of 30 square miles, six between 10 and 20 square miles, eleven between 4 and 10 square miles, the remainder varying between ½ square mile to 4 square miles, and mostly less than 2 square miles.

8. I need not further analyse Mr. Housden's proposals, because a lucid general report of his own is available, a copy of which has probably been furnished to the Local Administration of Rajputana.

This report was written by Mr. Housden in June 1885, four and a half months subsequent to his arrival in the Karauli State, after very thorough investigation and prospecting during this interval.

The report deals exhaustively with the prospects of irrigation works in the Karauli State, and supplies all the information now called for. It comprises several Appendices, lettered A. to G., the last of which consists of the series of sheets of the topographical survey of Gwalior and Central India, containing part of the Karauli State. On these sheets (*viz.*, 8, 8½, 10a, 10b, 39, 42, and 43) Mr. Housden marked all the sites noted by him.

The complete report was probably sent up, with the maps and plans accompanying, to the Secretary to the Agent to the Governor-General, as I have been able to find in the Agency Office of the Eastern States only the office copy of the report, without some of its accompaniments, which were probably forwarded uncopied.

9. Mr. Housden made over charge of the Karauli Public Works to Alla Buksh, overseer, at the end of October 1886, and since then little effect appears to have been given to his recommendations.

10. In his transfer memo., dated 31st October 1886, Mr. Housden makes a brief final summary of the general principles which he recommends to be followed in the prosecution of Public Works in the State, and he records the submission of several separate projects in detail.

11. In view of the completeness of the record which Mr. Housden left behind him, it is almost superfluous for me to do more than draw attention to it, but I may be permitted to mention briefly the following principal features which he has thoroughly elucidated.

12. The construction of Irrigation Works, to conserve the water supply and bring waste land into cultivation, would be highly beneficial to the people and ultimately remunerative to the revenue.

13. The main difficulty in following the programme sketched by Mr. Housden is financial. Mr. Housden deals with this difficulty, and makes definite proposals for the borrowing of capital.

14. Mr. Housden recommends that a beginning should be made by the carrying out of two large projects which he considers really good remunerative investments, *viz.* the proposed Gotra Tank to cost Rs. 90,000 and the proposed Nindhar Tank to cost Rs. 40,000. These projects are sufficiently remunerative to justify borrowing of capital.

15. Most of the other schemes would be desirable if money were available to carry them out, and Mr. Housden recommends that they should be taken in hand by degrees as funds are available from current revenue, or without borrowing capital at a higher rate of interest than its investment in Irrigation Works could be safely calculated to afford.

16. The valuable researches made by Mr. Housden into the possibilities of the improvements of the Karauli State should not be allowed to pass into oblivion. He strongly recommends a revenue survey of the State, the need for which is explained in his report. He devotes considerable attention to the question of the construction of wells. He refers also to the possibilities of a large system of Canal Irrigation from perennial streams.

17. If any more information is required to be abstracted I shall be happy to give any assistance in my power, and if, at any time, it should be considered feasible to renew a commencement of irrigation enterprises in the Karauli State, I should be very pleased to submit proposals after a further study of Mr. Housden's recommendations, and after a short visit to the locality.

No. XI.

**Descriptive List of Irrigation Projects proposed for the
Karauli State, Rajputana, by Mr. C. E. Housden,
Executive Engineer.**

Descriptive List of Irrigation Projects proposed for the Karauli State, Rajputana, by Mr. C. E. Housden, E. E.

1	2	3	ESTIMATED CULTURABLE AREA TO BE IRRIGATED IN BIGHAS.				7	8	9
Serial No.	Name of Work or Project.	Estimated costs in round figures.	Inside the Basin.	Outside or below the reservoir.	Total area irrigable.	Total maximum revenue derivable from the work annually.	Estimated percentage of direct return in annual revenue from the outlay.	REMARKS. (Copied from Mr. Housden's Note-book).	
5	Proposed tank at Pipalkhera. Catchment area 4 square miles.	8,000	...	...	...	...	.....	<i>Vide Sheet No. 8 of Map.—(Contd.).</i> (5) Proposed tank at Pipalkhera (<i>vide</i> Mr. Housden's Note-book No. I, Site No. 5 in his Sheet No. 8). The remarks in the Note-book are:— "Not a good project, but desired by the villagers."
6	Proposed small tank at Pipalkhera. Catchment area 2 square mile.	1,700	...	...	...	...	.....	(6) Proposed small tank at Pipalkhera (<i>vide</i> Mr. Housden's Note-book No. I, Site No. 6 in his Sheet No. 8). The remarks in the Note-book are:— "A small dam is required here to prevent the fields from cutting away and for upkeep of present revenue. Much desired by the villagers."
7	Repairs to present tank at Meola. Catchment area 1 square mile.	...	...	...	...	...	.....	<i>Vide Sheet No. 8½ of Map.</i> (7) Repairs to present tank at Meola (<i>vide</i> Mr. Housden's Note-book No. I, Site No. 1 in his Sheet 8½). The remarks in the Note-book are:— "There is a tank here which requires to be cleaned out and deepened. The villagers are willing to carry out the necessary repairs if a Tuccavi advance of 200 Rupees is made to them. This has, I hear from the Deputy Collector, since been done."

8	Tank at Chamar Aola. Catchment area 3 square miles.	...	...	...	...	...	...	(8) Tank at Chamar Aola (<i>vide</i> Mr. Housden's Note-book No. 1, Site No. 2 in his Sheet No. 8½). The remarks in the Note-book are:— "It is one of the few tanks which have retained water to date (February 1885). It would be better for a little deepening and cleaning out. 1,000 Rs. could with advantage be spent on it."
9	Tank at Bhojpur (improvement). Catchment area 1 square mile.	2,000	...	...	200	600	30 percent	(9) Tank at Bhojpur—improvement—(<i>vide</i> Mr. Housden's Note-book No. 1, Site No. 3 in his Sheet No. 8½). The remarks in the Note-book are:— "It is without doubt the best sheet of water in Kurauli. The tank bund leaks badly and the sluices which conduct away the water which filters through, require to be improved. (See general report.) A regular sluice might also with advantage be provided and more use made of the water stored than is done at present."
10	Proposed new tank at Bhojpur. Catchment area 2 square miles.	...	...	...	...	600	8-1	(10) Proposed new tank at Bhojpur (<i>vide</i> Mr. Housden's Note-book No. 1, Site No. 4 in his Sheet No. 8½).
11	Proposed new tank at Madanpur. Catchment area 3 square miles.	17,000	300	200	500	1,000	57	(11) Proposed new tank at Madanpur (<i>vide</i> Mr. Housden's Note-book No. 1, Site No. 5 in his Sheet No. 8½). The remarks in the Note-book are:— "This would be a large tank. The bund being over 2,000 ft. in length. A core-wall absolutely necessary."
12	Proposed tank at Anajara. Catchment area 2½ square miles.	35,000	...	...	500	1,500	5	(12) Proposed tank at Anajara (<i>vide</i> Mr. Housden's Note-book No. 1, Site No. 6 in his Sheet No. 8½). The remarks in the Note-book are:— "There is an old bund here. The villagers here want it repaired, which cannot be done except at considerable expense owing to the nature of the ground, etc."
13	Proposed completing old tank at Malpur Naraina. Catchment area 4 square miles.	31,500	...	...	500	1,500	4½	(13) Proposed completing old tank at Malpur Naraina (<i>vide</i> Mr. Housden's Note-book No. 1, Site No. 7 in his Sheet No. 8½).

Descriptive List of Irrigation Projects proposed for the Karauli State, Rajputana, by Mr. C. E. Housden, E. E.

Serial No.	Name of Work or Project.	3	ESTIMATED CULTIVABLE AREA TO BE IRRIGATED IN BIGHAS.			7	8	9
			4	5	6			
		Estimated cost in round figures.	Inside the Basin.	Outside or below the reservoir.	Total area irrigable.	Total maximum revenue derivable from the work annually.	Estimated percentage of direct return in annual revenue from the outlay.	REMARKS.
14	Proposed tank near Machilpur (to N.-W.) Catchment area 2 square miles.	21,000	...	...	1,000	1,300	6½ per cent.	(14) Proposed tank near Machilpur (to N.-W.) Catchment area 2½ square miles (<i>vide</i> Mr. Housden's Note-book No. I, Site No. 8 in his Sheet No. 8½).
15	Proposed tank at Runokapura. (East of Machilpur). Catchment area 3 square miles.	27,500	...	...	1,000	3,000	15 "	(15) Proposed tank at Runokapura—East of Machilpur—(<i>vide</i> Mr. Housden's Note-book No. I, Site No. 9 in his Sheet No. 8½). The remarks in the Note-book are:— "There is a good site for a tank here, (see general report).
16	Proposed tank at Kasar. (Madan Sagar) Catchment area 3 square miles.	3,000	...	...	200	600	.....	(16) Proposed tank at Kasar—Madan Sagar—(<i>vide</i> Mr. Housden's Note-book No. I, Site No. 10 in his Sheet No. 8½). The remarks in the Note-book are:— "The money would be well spent."
17	Proposed tank at Sohara. Catchment area 1½ square miles.	16,300	...	...	625	1,875	11½ "	(17) Proposed tank at Sohara (<i>vide</i> Mr. Housden's Note-book No. I, Site No. 11 in his Sheet No. 8½). The remarks in the Note-book are:— "There is a good Site for the tank. As the project is an important one, I have made out separate plans and estimates for it which is given below."

18	Proposed tank at Barai. Catchment area $\frac{1}{2}$ square mile.	16,000	...	...	...	...	.....	(18) Proposed tank at Barai (<i>vide</i> Mr. Housden's Note-book No. I, Site No. 12 in his Sheet No. 84). The remarks in the Note-book are:— "The bund commenced, unfortunately belongs, I find, to Gadholi; a village belonging to the Baroda Kani. The Site is noted in case the village should at any time revert to the State."
19	Proposed tank near Tatwaie. Catchment area 2 square miles.	...	...	...	...	...	.....	(19) Proposed tank near Tatwaie (<i>vide</i> Mr. Housden's Note-book No. I, Site No. 13 in his Sheet No. 84). The remarks in the Note-book are:— "There is a fair Site for the tank here. The village is, however, not a Khalsa one. No estimate is in consequence made out. Irrigation from the tank is not possible or some of the water which the tank would store, could be utilized on Khalsa lands in the valley below." "Cultivable land likely to be affected by the tank is all included in what would be the best of the tank."
20	Proposed tank at Balloopura. Catchment area $2\frac{1}{2}$ square miles.	19,500	...	400	1,200	9.2 per cent.	.....	(20) Proposed tank at Balloopura (<i>vide</i> Mr. Housden's Note-book No. I, Site No. 14 in his Sheet No. 84). The remarks in the Note-book are:— "There is a good Site for the tank here." (See general report).
21	Tank at Rudar. Catchment area 1 square mile.	3,800	...	100	300	.....	.....	(21) Tank at Rudar (<i>vide</i> Mr. Housden's Note-book No. I, Site No. 15 in his Sheet No. 84). The remarks in the Note-book are:— "A deep and narrow nullah has had to be dammed up to prevent its increasing and washing away the fields about Rudar. The best thing to do is to dam up the nullah completely by a large earthen bund, providing, at the same time, to one side a masonry weir over which any surplus water can escape."
22	Proposed 2nd tank near Sohara. Catchment area 1 square mile.	4,400	...	...	...	.....	.....	(22) Proposed 2nd tank near Sohara (<i>vide</i> Mr. Housden's Note-book No. I, Site No. 16 in his Sheet No. 84). The remarks in the Note-book are:— "For drinking purposes, especially asked for by the villagers."

Descriptive List of Irrigation Projects proposed for the Karauli State, Rajputana, by Mr. C. E. Housden, E. E.

Serial No.	2	3	ESTIMATED CULTURABLE AREA TO BE IRRIGATED IN DIGHAS.			7	8	9
			4	5	6			
	Name of Work or Project.	Estimated cost in round figures.	Inside the Basin.	Outside or below the reservoir.	Total area irrigable.	Total maximum revenue derivable from the work annually.	Estimated percentage of direct return in annual revenue from the outlay.	REMARKS. (Copied from Mr. Housden's Note-book).
<i>Vide Sheet No. 8½ of Map.—(Contd.)</i>								
23	Proposed tank at Golahara. Catchment area 2 square miles.	49,000	...	...	750	2,250	4½ per cent	(23) Proposed tank at Golahara (<i>vide</i> Mr. Housden's Note-book No. I, Site No. 17 in his Sheet No. 8½). The remarks in the Note-book are— "A long narrow and deep tank can be formed here by the construction of a short but high dam."
24	Proposed 3rd tank near Sohara (Kasra). Catchment area 1 square mile.	7,500	...	...	100	...	.....	(24) Proposed 3rd tank near Sohara (<i>vide</i> Mr. Housden's Note-book No. I, Site No. 18 in his Sheet No. 8½).
25	Proposed tank at Gotra. Catchment. area 3 square miles.	...	...	...	...	...	.....	(25) Proposed tank at Gotra (<i>vide</i> Mr. Housden's Note-book No. I, Site No. 19 in his Sheet No. 8½). The remarks in the Note-book are :— "There is a good Site for a tank here. The land commanded unfortunately belongs to a Thakur."
26	Proposed tank at Garh. Catchment area 2½ square miles.	...	...	...	...	...	...	(26) Proposed tank at Garh (<i>vide</i> Mr. Housden's Note-book No. I, Site No. 20 in his Sheet No. 8½). The remarks in the Note-book are :— "A good tank could be made at the spot shown in the sketch. There is any amount of good land. The village of Garh belongs to a brotherhood of small Thakurs who are anxious to construct a tank, or sink wells, if a Tuccavi advance be made them from the State."

27	Repairs to a small tank at Lakhinpur. Catchment area 1 square mile.	200	...	...	...	...	...	(27) Repairs to small tank at Lakhinpur (<i>vide</i> Mr. Housden's Note-book No. I, Site No. 21 in his Sheet No. 8½). The remarks in the Note-book are:— "No increase in revenue can be expected as the up-keep of the present revenue is all that can be looked for. The tank has silted and requires to be cleaned out."
28	Proposed tank at Latoha. Catchment area 1 square mile.	9,000 ✓	...	300	900	10 p. cent.	...	(28) Proposed tank at Latoha (<i>vide</i> Mr. Housden's Note-book No. I, Site 22 in his Sheet No. 8½). The remarks in the Note-book are:— "This is a good Site for the tank, better I think than the next one; only one of these is required. Before a definite opinion can be given as to which is the better one of the two, detailed plans will have to be got out, and the relative merits of the two Sites compared. The villagers are anxious to have the tank at Site No. 23. I think myself that Site No. 22 is to be preferred."
28 (a)	Do. do. Alternative project. Catchment area 3 square miles.	14,800	...	400	1,200	8-1 "	...	(28a) Proposed tank at Latoha alternative project (<i>vide</i> Mr. Housden's Note-book No. I, Site No. 23 in his Sheet No. 8½). The remarks in the Note-book are:— "The villagers who much desire a tank at this place prefer this Site (No. 23) to No. 22. The former is in my opinion a cheaper and on the whole though less land is commanded, a better one."
29	Tank at Sillaoti. Catchment area ½ square mile.	...	...	...	...	.....	...	(29) Tank at Sillaoti (<i>vide</i> Mr. Housden's Note-book No. I, Site No. 24 in his Sheet No. 8½). The remarks in the Note-book are:— "The tank here has silted up and Rs. 500 could be well spent in cleaning it out. The villagers are willing to pay Rs. 25 a year to the State if the tank is kept in repair for them."
30	Proposed tank at Garhi. Catchment area 1 square mile.	...	...	...	...	.....	...	(30) Proposed tank at Garhi (<i>vide</i> Mr. Housden's Note-book No. I, Site No. 25 in his Sheet No. 8½). The remarks in the Note-book are:— "There is a likely spot for a tank here, from the bund the valley below could be irrigated. I took no measurements as I came across the site when hurrying on to Camp. It is noted, however, as I am confident that a good tank can be made here."

Descriptive List of Irrigation Projects proposed for the Karauli State, Rajputana, by Mr. C. E. Housden, E. E.

Serial No.	2	3	ESTIMATED CULTURABLE AREA TO BE IRRIGATED IN BIGHAS.			7	8	9
			4	5	6			
	Name of Work or Project.	Estimated cost in round figures.	Inside the Basin.	Outside or below the reservoir.	Total irrigable area.	Total maximum revenue derivable from the work annually.	Estimated percentage of direct return in annual revenue from the outlay.	REMARKS (Copied from Mr. Housden's Note-book).
31	Proposed tank at Gosai. Catchment area 1 square mile.	6,000	..	..	400	1,200	.....	<i>Vide Sheet No. 10b of Map.</i> (31) Proposed tank at Gosai (<i>vide</i> Mr. Housden's Note-book No. I, Site No. 1 in his Sheet No. 10b). The remarks in the Note-book are:— "A good Site (see general report)."
32	Proposed tank at Karanpur. Catchment area 3 square miles.	10,000	200	..	200	600	6 per cent.	(32) Proposed tank at Karanpur (<i>vide</i> Mr. Housden's Note-book No. I, Site No. 2 in his Sheet No. 10b). The remarks in the Note-book are:— "A fair Site."
33	Proposed tank at Thorah. Catchment area 2½ square miles.	20,700	300	..	300	900	4.3 "	(33) Proposed tank at Thorah (<i>vide</i> Mr. Housden's Note-book No. I, Site No. 3 in his Sheet No. 10b). The remarks in the Note-book are:— "Not a good Site. Included at the express desire of the villagers."
34	Tank at Simarah. (Repairs) Catchment area 1½ square miles.	..	..	..	..	..	.....	(34) Tank at Simarah—Repairs—(<i>vide</i> Mr. Housden's Note-book No. I, Site 4 in his Sheet No. 10b). The remarks in the Note-book are:— "Repairs to two small tanks wanted here (see general report). The villagers have undertaken to repair one tank themselves."

35	Proposed tank at Arora. Catchment area 16 square miles.	30,000	...	...	100	3,000	10 per cent.	(35) Proposed tank at Arora (<i>vide</i> Mr. Housden's Note-book No. I, Site No. 5 in his Sheet No. 10b). The remarks in the Note-book are:— "This a good project; for further details see general report."
36	Nullah at Radai. Catchment area 1 square mile.	30,000	...	...	550	1,650	5½	(36) Nullah at Radai (<i>vide</i> Mr. Housden's Note-book No. I, Site No. 6 in his Sheet No. 10 b). The remarks in the Note-book are:— "This nullah to the village of Radai is fast cutting away the fields. Probably the best way to prevent this is to try and keep the water out of the nullah as far as possible by (1) throwing bunds across the main tributaries (where it is possible to do so) of sufficient size, to form tanks capable of storing all the water likely to come down; and (2) running a small bund all round the nullah to retain the surface drift."
37	Dabra Tank Sluice. " Canal. Catchment area 20 square miles.	2,332 6,160	...	...	1,200	4,000	.....	<i>Vide</i> Sheet No. 42 of Map. (37) Dabra tank Sluice } (<i>vide</i> Mr. Housden's Note-book No. III, Site No. 1 in his Sheet No. 42). The remarks in the Note-book are:— "This tank was built a few years ago, a good deal of land being cultivated round the margin outside of the bed proper. A Sluice is now being supplied at the point marked, from which if the tank in future years retains water a canal can be supplied."
38	Proposed tank at Gotra. Catchment area 4 square miles.	75,000	...	...	5,000	15,000	20 per cent.	(38) Proposed tank at Gotra (<i>vide</i> Mr. Housden's Note-book No. III, Site No. 2 in his Sheet No. 42). The remarks in the Note-book are:— "A full report on the project has already been submitted."
39	Proposed tank at Garain. Catchment area 15 square miles.	...	...	...	...	...	.....	(39) Proposed tank at Garain (<i>vide</i> Mr. Housden's Note-book No. III, Site No. 8 in his Sheet No. 42). The remarks in the Note-book are:— "Should the proposed tank at Gotra not store all the water, a Supplementary tank can be formed by a bund either at A or B. A cross section of the former Site is given. That of the latter is somewhat similar."
40	Proposed tank at Rirkhera. Catchment area 1½ square miles.	7,200	...	...	100	200	2½	(40) Proposed tank at Rirkhera (<i>vide</i> Mr. Housden's Note-book No. III, Site No. 4 in his Sheet No. 42). The remarks in the Note-book are:— "The villagers want an earthen bund thrown across the valley here. This would retain the drainage and allow of wheat being grown in the bed of the tank so formed."

45	Proposed 2nd tank at Dabra (below present tank). Catchment area 5 square miles.	17,000	...	...	500	1,500	9 per cent.	(45) Proposed 2nd tank at Dabra—below present tank—(vide Mr. Housden's Note-book No. III, Site No. 9 in his Sheet No. 42). The remarks in the Note-book are:— "To reclaim broken land which can be afterwards irrigated from the Dabra tank."
46	Proposed Sapotra tank. Catchment area 1½ square miles.	5,200	100	...	100	300	5½ "	(46) Proposed Sapotra tank (vide Mr. Housden's Note-book No. III, Site No. 10 in his Sheet No. 42). The remarks in the Note-book are:— "There is a good Site for a small tank here."
47	Proposed Amergarh Weir. Catchment area 30 square miles.	...	...	...	...	...	.....	(47) Proposed Amergarh Weir (vide Mr. Housden's Note-book No. III, Site No. 11 in his Sheet No. 42). The remarks in the Note-book are:— "(See General Report). I have not made out the estimate as the land likely to be benefitted is not Khalsa land."
48	Amergarh tank. Catchment area 8 square miles.	16,900	...	...	2,000 (3,000)	3,000	.....	(48) Amergarh tank (vide Mr. Housden's Note-book No. III, Site No. 12 in his Sheet No. 42). The remarks in the Note-book are:— "This tank is now under construction by the Thakur of Amergarh. It is estimated to cost Rs. 14,927 as detailed in the estimate. Two dams on previous occasions have been built here and have in each instance been carried away. They were badly built. It is estimated that the water stored in the bed will cover 2,000 bighas and that after it has been drained off, 1,000 bighas will be brought under cultivation and in time yield a revenue of Rs. 3,000."
49	Proposed Amerwar tank. Catchment area 2 square miles.	11,000	...	...	300	900	8 2 percent.	(49) Proposed Amerwar tank (vide Mr. Housden's Note-book No. III, Site No. 13 in his Sheet No. 42). The remarks in the Note-book are:— "There is a good deal of broken ground to the north-west of Amerwar which the construction of a dam at the Site shown on the plan, would reclaim. As the stream is here a perennial one the water level in the tank would, by regulating the sluice, be retained at any desired level."
50	Proposed tank at Lohera. Catchment area is only 3 square miles.	21,500	...	...	500	1,500	7 "	(50) Proposed tank at Lohera (vide Mr. Housden's Note-book No. III, Site No. 14 in his Sheet No. 42). The remarks in the Note-book are:— "There is a very good Site for a tank here, by the construction of which, should it ever fill properly, nearly 1,000 bighas of good land can be brought under cultivation. It is probable therefore that the tank would only be quite full in exceptionally good years. 500 bighas can then ordinarily be only reckoned on the estimate given."

Descriptive List of Irrigation Projects proposed for the Karauli State, Rajputana, by Mr. O. E. Housden, E. E.

1	2	3	ESTIMATED CULTURABLE AREA TO BE IRRIGATED IN BIGHAS.			7	8	9
		Estimated cost in round figures.	4	5	6	Total maximum revenue derivable from the work annually.	Estimated percentage of direct return in annual revenue from the outlay.	REMARKS.
Serial No.	Name of Work or Project.		Inside the Basin.	Outside or below the reservoir.	Total area irrigable.			(Copied from Mr. Housden's Note-book).
51	Proposed tank near Bassai. Catchment area is a large one. Catchment area 5 square miles.	20,000	...	...	500	2,000	10 per cent.	<i>Vide Sheet No. 42 of Map.—(Contd.)</i> (51) Proposed tank near Bassai (<i>vide</i> Mr. Housden's Note-book No. III, Site No. 15 in his Sheet No. 42). The remarks in the Note-book are:— "There is a good Site for a tank here. I unfortunately have not got a section, but I should say that a fair tank could be made for about Rs. 20,000, capable of irrigating 500 bighas of good land at present lying waste. The tank ought consequently to fill well. No revenue is at present derived from the land which could be commanded by the tank." (52) Proposed tank at Attaywa (<i>vide</i> Mr. Housden's Note-book No. III, Site No. 16 in his Sheet No. 42). The remarks in the Note-book are:— "There is a good Site for a tank here for bad cultivation. The stream being a perennial one, the water level in the tank can be regulated the sluice be kept at any required height and the fields thus irrigated." (53) Proposed 2nd tank at Attaywa (<i>vide</i> Mr. Housden's Note-book No. III, Site No. 17 in his Sheet No. 42). The remarks in the Note-book are:— "By the construction of a small and high bund here, a deep tank capable of storing 80 m.c.ft. can be formed. This amount is capable of irrigating 1,000 bighas and this area of land is commanded. There may however, owing to its not being quite level, be some difficulty in bringing the full area under the influence of the proposed tank and so only 500 bighas are taken into calculation."
52	Proposed tank at Attaywa. Catchment area 5 square miles.	14,500	...	...	300	900	6½	
53	Proposed 2nd tank at Attaywa. Catchment area ½ square miles.	17,500	...	...	500	1,500	8½	

54	Proposed Tham tank. Catchment area 3 square miles.	...	...	...	...	...	...	...	(54) Proposed Tham tank (<i>vide</i> Mr. Housden's Note-book No. III, Site No. 18 in his Sheet No. 42). The remarks in the Note-book are:— "The villagers of Tham want a bund at the Site shown on the plan. A simple earthen one would do. I do not, however, recommend its construction till experience has shown that the Dabra tank fills well. The construction of the tank now under notice, would interfere with the drainage into the Dabra tank. The latter has not filled properly for the last two years."
55	Proposed tank at Jakhoda. Catchment area 7 square miles.	...	...	...	...	...	...	...	(55) Proposed tank at Jakhoda (<i>vide</i> Mr. Housden's Note-book No. III, Site No. 19 in his Sheet No. 42). The remarks in the Note-book are:— "There is a good Site for a tank at Jakhoda. No measurements made. The Site is simply noted as a good one to be afterwards examined and worked up."
56	Tank at Nyuci Goari. " with duct. Catchment area 3 square miles.	20,000 21,000	...	...	...	400 .700	1,200 1,800	3 6 per cent.	<i>Vide Sheet No. 43 of Map.</i> (56) Tank at Nyuci Goari (<i>vide</i> Mr. Housden's Note-book No. III, Site No. 1 in his Sheet No. 43). The remarks in the Note-book are:— "This tank is now approaching completion. Its cost will be close on Rs. 20,000. The quantity of water stored is 48 m.c.f. or sufficient for 800 bighas. The area commanded 400 bighas, anticipated Revenue from tank Rs. 1,200. By the construction of a duct another 300 bighas can be brought under the influence of the tank and another Rs. 600 realized. Cost of duct is Rs. 1,000."
57	Repairs to tank at Maidpura. Catchment area $\frac{1}{2}$ square mile.	...	...	...	...	...	...	...	(57) Repairs to tank at Maidpura (<i>vide</i> Mr. Housden's Note-book No. III, Site No. 2 in his Sheet No. 43). The remarks in the Note-book are:— "(See General Report) and report submitted with Executive Engineer's No. 26, dated 25th March 1885. The necessary repairs and alterations are now in hand and are shown in red in the drawing. The main object of the repairs is the preservation of the tank and the up-keep of the present revenue. It is hoped, however, that the tank will now store sufficient water to allow of a rabi crop being raised from the land commanded. The State would get a third and thus benefit."

Descriptive List of Irrigation Projects proposed for the Karauli State, Rajputana, by Mr. C. E. Housden, E. E.

1	2	3	ESTIMATED CULTURABLE AREA TO BE IRRIGATED IN DIGHAS.			7	8	9
Serial No.	Name of Work or Project.	Estimated cost in round figures.	Inside the Basin.	Outside or below the section.	Total area irrigable.	Total maximum revenue derivable from the work annually.	Kalimati percentage of direct return in annual revenue from the outlay.	REMARKS. (Copied from Mr. Housden's Note-book).
<i>Vide Sheet No. 43 of Map.—(Contd.)</i>								
58	Alterations and improvements to tank at Dowlatpur Kalianpur Catchment area 3 square miles.	5,600	..	..	..	..	..	(58) Alterations and improvements to tank at Dowlatpur Kalianpur (<i>vide</i> Mr. Housden's Note-book III, Site 3 in his Sheet No. 43). The remarks in the Note-book are:— "(See General Report) Upkeep of present revenue."
59	Proposed tank at Chand-ka-Bara. Catchment area 1½ square mile.	3,000	..	..	50	150	5 per cent	(59) Proposed tank at Chand-ka-Bara (<i>vide</i> Mr. Housden's Note-book No. III, Site No. 4 in his Sheet No. 43). The remarks in the Note-book are:— "(See General Report) A better Site can possibly be found for a tank here. One is badly wanted."
60	Proposed tank at Kanarda. Catchment area 10 square miles.	23,300	..	..	800	2,400	10 "	(60) Proposed tank at Kanarda (<i>vide</i> Mr. Housden's Note-book No. III, Site No. 5 in his Sheet No. 43). The remarks in the Note-book are:— "This is a very good Site. As this stream is a mountain torrent and there is rock at no great distance from the surface, it would perhaps be advisable to make the dam of masonry in line throughout. Type A, is therefore recommended."
61	Proposed tank at Guta. Catchment area 8 square miles.	4,700	..	..	200	600	12½ "	(61) Proposed tank at Guta (<i>vide</i> Mr. Housden's Note-book No. III, Site No. 6 in his Sheet No. 43). The remarks in the Note-book are:— "The Site is a bad one, the best kind of dam would perhaps be a large earthen bund similar to the one under construction at Jaipur (as Type C). Asked for by the villagers but not recommended."

62	Proposed tank at Deopur. Catchment area 1½ square miles.	23,600	500	...	500	...	500	1,500	6	"	(62) Proposed tank at Deopur (<i>vide</i> Mr. Housden's Note-book No. III, Site No. 7 in his Sheet No. 43). The remarks in the Note-book are:— "A somewhat similar Site to the one at Kanarda."
63	Tank at Madanpur. Catchment area 2 square miles.	4,000	...	...	...	250	500	12½	"	"	(63) Tank at Madanpur (<i>vide</i> Mr. Housden's Note-book No. III, Site No. 8 in his Sheet No. 43). The remarks in the Note-book are:— "There is a half finished tank here, which might be completed as shown in red in the drawing. There is a good deal of land below the tank which can be irrigated from it if it holds water."
64	Proposed tank at Durgasi. Catchment area 50 square miles.	4,50,000	...	...	...	...	...	.....	.....	.....	(64) Proposed tank at Durgasi (<i>vide</i> Mr. Housden's Note-book No. III, Site No. 1 in his Sheet No. 10a). The remarks in the Note-book are:— "(See General Report). The project is one which might with advantage be worked out in detail. If in some way the waters of the perennial "Barkhera" could be diverted into the land about Karauli, immense benefit would result therefrom. A separate note is put up on this project."
65	Proposed tank at Nindar. Catchment area 18 square miles.	4,50,000	...	...	...	4,000	10,000	32 per cent.	32 per cent.	32 per cent.	(65) Proposed tank at Nindar (<i>vide</i> Mr. Housden's Note-book No. III, Site No. 2 in his Sheet No. 10a). The remarks in the Note-book are:— "There is a good Site here for a large Reservoir. Complete details and plans have already been submitted, with Executive Engineer's No. 63k, dated 18th May 1885."
66	Proposed tank at Markakoa. Catchment area 16 square miles.	38,300	600	...	...	600	1,800	4·7	"	"	(66) Proposed tank at Markakoa (<i>vide</i> Mr. Housden's Note-book No. III, Site No. 3 in his Sheet No. 10a). The remarks in the Note-book are:— "There is a good Site for a tank here by which a large area of broken ground can be reclaimed."
67	Proposed tank at Khirak. Catchment area 1½ square miles.	10,700	...	...	...	250	500	5	"	"	(67) Proposed tank at Khirak (<i>vide</i> Mr. Housden's Note-book No. III, Site 4 in his Sheet No. 10a). The remarks in the Note-book are:— "A small tank to reclaim broken ground."

Descriptive List of Irrigation Projects proposed for the Karauli State, Rajputana, by Mr. O. E. Housden, E. E.

1	2	3	4			5	6	7	8	9
Serial No.	Name of Work or Project.	Estimated costs in round figures.	ESTIMATED CULTURABLE AREA TO BE IRRIGATED IN BIGHAS.			Total area irrigable.	Total revenue derivable from the work annually.	Estimated percentage of direct return in annual revenue from the outlay.	REMARKS (Copied from Mr. Housden's Note-book).	
			Inside the Basin.	Outside or below the reservoir.	...					
<i>Vide Sheet No. 10a of Map.—(Contd.)</i>										
68	Tank at Gopalpur (repairs). Catchment area $\frac{1}{2}$ square mile.	250	...	...	...	...	...	...	(68) Tank at Gopalpur—repairs—(vide Mr. Housden's Note-book No. III, Site No. 5 in his Sheet No. 10a). The remarks in the Note-book are :— "A small tank here, wanting repairs."
69	Proposed tank at Moorila. Catchment area 1.	4,300	...	...	...	100	200	5 per cent	(69) Proposed tank at Moorila (vide Mr. Housden's Note-book No. III, Site No. 6 in his Sheet No. 10a).
70	Proposed tank at Seapoor. Catchment area 2 square miles.	19,200	...	...	...	500	1,500	1.3 "	(70) Proposed tank at Seapoor (vide Mr. Housden's Note-book No. III, Site No. 7 in his Sheet No. 10a). The remarks in the Note-book are :— "Commands 500 bighas of fair ground rather broken up at present but which can easily be converted into terraced fields."
71	Proposed small tank at Durroora. Catchment area 2 square miles.	10,800	...	...	...	150	450	4½ "	(71) Proposed small tank at Durroora (vide Mr. Housden's Note-book No. III, Site No. 8 in his Sheet No. 10a). The remarks in the Note-book are :— "A small tank for rice."
72	Proposed tank at Manakhor. Catchment area 1 square mile.	14,750	...	...	...	...	...	.....	(72) Proposed small tank at Manakhor (vide Mr. Housden's Note-book No. III, Site No. 9 in his Sheet No. 10a). The remarks in the Note-book are :— "Included at the express desire of the villagers. There are only 25 bighas of land below the tank. Its construction would prevent some fields from cultivation, not recommended. Practically no return."

Vide Sheet No. 10a of Map.—(Contd.)

73	Proposed tank at Mohanpura. Catchment area 6 square miles.	2,250	...	...	45	225	10 per cent.	(73) Proposed tank at Mohanpura (<i>vide</i> Mr. Housden's Note-book No. III, Site No. 10 in his Sheet No. 10a). The remarks in the Note-book are:— "Masonry weir providing a superior sort of 'Pokhur' (See General Report)."
74	Proposed tank at Pasala (dam). Catchment area $\frac{1}{2}$ square mile.	5,100	...	...	50	250	5 "	(74 & 75) Proposed tank at Pasala (<i>vide</i> Mr. Housden's Note-book No. III, Site No. 11 in his Sheet No. 10a).
75	Do. do. for rice. Catchment area $\frac{1}{2}$ square mile.	10,900	...	...	90	450	4 $\frac{1}{2}$ "	
76	Repairs to tank at Bherda. Catchment area 8 square miles.	1,500	...	...	...	...	.....	(76) Repairs to tank at Bherda (<i>vide</i> Mr. Housden's Note-book No. III, Site No. 12 in his Sheet No. 10a). The remarks in the Note-book are:— "The earth has been washed away from between the two wells. It would perhaps be advisable to alter the section of the dam to that shown in <i>red</i> ."
77	Repairs to tank at Markapura. Catchment area 1 $\frac{1}{2}$ square miles.	1,700	...	...	...	240	14 "	(77) Repairs to tank at Markapura (<i>vide</i> Mr. Housden's Note-book No. III, Site No. 13 in his Sheet No. 10a). The remarks in the Note-book are:— "This has recently been repaired (See General Report)"
78	Tank at Khoob Nagar (dam). Catchment area $\frac{1}{2}$ square mile.	293	...	...	...	...	... "	(78) Tank at Khoob Nagar (dam) (<i>vide</i> Mr. Housden's Note-book No. III, Site No. 14 in his Sheet No. 10a). The remarks in the Note-book are:— "The Nullah was constantly cutting the land away. The Overseer stopped this by constructing an earthen dam with a masonry core, as shown on the drawing. The damaged fields are now silting up."
79	Repairs to two old tanks near Mandrael. Catchment area 2 $\frac{1}{2}$ square miles.	30	(79) Repairs to two old tanks near Mandrael (<i>vide</i> Mr. Housden's Note-book No. III, Site No. 16 and 17 in his Sheet No. 10a). The remarks in the Note-book are:— "Two small tanks to the east of Mandrael have been breached for years. The breaches are small ones, only 35 long and might long ago have been repaired. As the tanks are without weirs the proposal now put forward is to convert these breaches into weirs as shown in the sketch."

NOTE

BY

THE CONSULTING ENGINEER FOR IRRIGATION
IN RAJPUTANA

1904.

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TO

NOTE BY THE CONSULTING ENGINEER FOR IRRIGATION IN RAJPUTANA.

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NOTE BY THE CONSULTING ENGINEER FOR IRRIGATION IN RAJPUTANA.

1.—As regards the Karauli State, when the option was given to the Karauli Durbar to join with the other Native States in a scheme of investigation regarding Irrigation, the Durbar expressed their readiness to do so, and their appreciation of the liberality and kindness of the Government of India, in their letter No. 329, dated 6th November 1902, to the Political Agent, Eastern Rajputana States—"With reference to your letter No. 5019, dated 19th September 1902, regarding the scheme of a systematic examination of the whole of Rajputana on the question of Irrigation, as recommended by the Irrigation Commission appointed by the Government of India, I have the honour to inform you, in reply to your enquiries respecting para. 5 of your letter, whether the Durbar of this State are willing to enter into a joint scheme as proposed by the Irrigation Commission, that they are ready to enter into a joint scheme. You are already aware that there is neither an Engineer and, for the matter of that, no Engineering establishment in this State. The Council of this State, from your letter and its enclosures, understand that the Government is prepared to lend the services of a competent Engineer, and in view of the impoverished condition of the finances of many of the States, the entire cost of the investigations will in the first instance be borne by the Imperial Government. This question of having the investigations carried out with the help of a competent Engineer is settled entirely to the advantage of this State, through the kindness and liberality of the Imperial Government, and the Durbar of this State fully appreciate the kindness. As has been stated above, there is no Engineering establishment in this State, and the question being an entirely technical one, the Durbar of this State are not in a position to express any opinion on it. How many Surveyors will be required, what establishment is to be entertained, all these questions, the Durbar of the State request you to decide and settle, having regard to the financial position of the State. In the opinion of the Council of this State, it would be more convenient if the work commenced from the month of January after the Coronation Durbar."

2.—In the meantime letter No. 115, dated 24th February 1903, was addressed to the Political Agent by the Consulting Engineer for Irrigation.

1. "With reference to the subject of Irrigation in Rajputana, I have been asked to communicate with you as regards the Karauli State.

2. From the correspondence which has already taken place (noted in the margin) you will doubtless have noticed the interest which the Government of India take in the subject :—

Letter No. 3255-I. A., dated 2nd August 1902, from the Government of India to the Hon'ble the Agent Governor-General in Rajputana.

- (a) The fact of the Irrigation Commission being appointed to collect all the information available.
 - (b) The promptness with which the recommendations made by the Commission have been acted upon, to appoint Special Officers to supervise the investigations considered necessary.
 - (c) The liberality with which the Government of India have acted, in undertaking to defray in the first instance the initial cost of the investigations. All these facts show that the Government of India are determined to do all that can be done to help the Native States in Rajputana.
3. Colonel Sir Swinton Jacob, who has for many years been in Rajputana, and has taken an interest in the subject, has, at the request of the Government of India, consented to forego his intention to retire, and has accepted the post of Consulting Engineer for Irrigation, with the hope of being able to help in the great object which the Government of India have in view, *viz.*, the welfare of the States of Rajputana.
 4. The Honorable the Agent Governor-General is assured that these disinterested efforts of the Government of India will be responded to in the same spirit by the Rulers of the Native States concerned.
 5. There are three stages of operations :—
 - (a) The investigation of such Catchment Area, from its head downward, to find out where dams can best be placed or water stored, and to ascertain all the possibilities in the way of Irrigation in each State. For this no detailed surveys are necessary.
 - (b) The inspection by the Consulting Engineer for Irrigation of all such proposals, to give assistance or advice where required.
 - (c) The preparations of proper Plans and Estimates for a certain number of approved projects in each State (see letter No. 329, dated 13th February 1902, para. 4, from the Secretary of the Irrigation Commission, to the Secretary to the Government of India, Revenue and Agriculture).
 6. It is at present to the first stage only that it is desired to direct the particular attention of all concerned. This investigation should be started at once by the Local Engineer Officers, who should take up the subject in real earnest. They should themselves examine every Catchment, or depute some intelligent subordinates to do so, and without going to the trouble of making out elaborate surveys or estimates, they should be able to place sufficient data before the Consulting Engineer as will enable him to form an opinion and give advice on the proposal.

7. If the State Engineer is able, with the existing establishment, to arrange for making the investigation, he should do so at once. If he is unable to do so, he should state without delay what extra establishment is required, and whether the State is prepared to meet the cost of this extra establishment.
8. Irrigation has admittedly not been taken up in many States of Rajputana with the energy and spirit that its importance deserves. The Government of India, in the interests of the States of Rajputana, desire that not a drop of water which can be stored and made use of, should be allowed to go to waste. It is only by the cordial co-operation of each Durbar, and the Local Engineers or Officials, that anything can readily be done to secure this great object.
9. May I ask you, therefore, to give the enclosed copies of this letter to the Durbar and to all concerned, with the hope that no time will be lost in making the required investigation, and informing the Consulting Engineer, so that he may go direct to the places marked and give any advice or assistance required. Time is short, the work is urgent, and should be done as soon as possible.
10. It should be clearly understood that no actual scheme will be commenced or any expenditure upon it incurred, without the express concurrence of the Chief within the limits of whose State it is situated."

3.—The State Council in acknowledging this letter state as follows:—(Their letter No. 87 of 1st April 1903). "I have the honor to acknowledge receipt of your office endorsement No. 933, dated 27th February 1903, forwarding a couple of copies of printed circular letter of Sir Swinton Jacob, in which he has briefly sketched out a plan as to how each State ought to follow a systematic method in its Irrigation operations, as recommended by the late Irrigation Commission appointed by the Government of India.

The authorities of this State would at once have practically followed the plan of operation as suggested by the Consulting Engineer of Rajputana, but for the fact that there was no Engineer or Engineering Establishment in this State. As the question is a very important one, which ought immediately to engage the attention of the authorities of this State, the Council again drew the attention of the Maharaja, and it has now been settled to engage a passed Overseer of the Civil Engineering College, Roorki, with some experience in Irrigation Works. He is to be employed from the beginning of *Asarh* (or June 1903) next.

The present financial year closes with the month of *Jeth* and thus the new man is to be engaged from the commencement of the new financial year, when the Overseer will have the further advantage, owing to the setting-in of the rains, of inspecting the courses of water and water channels at different spots and to examine the different Catchment areas. Steps have already been taken to secure a suitable candidate."

The fact that Mr. Housden, Executive Engineer, was deputed in 1884-86 to the Karauli State to investigate for Irrigation Works, and had submitted a report, appears to have been forgotten.

4.—Mr. Housden made a thorough reconnaissance of the State and submitted a very complete report. Mr. Devenish, State Engineer, Bharatpur (in his letter No. 2316, dated 24th March 1901), abstracts the result of Mr. Housden's work, and prepared a statement giving a list of the projects, the estimated cost, area irrigable, and probable revenue of each; 79 projects had been investigated and proposed by Mr. Housden, and sketched plans and approximate estimates prepared.

The largest project, Durgasi, was estimated to cost Rs. 4,50,000, and the total of the rest amounted to about 8½ lakhs.

The Gotra Tank project, estimated to cost Rs. 75,000, and the Nindar project Rs. 45,000, were the two projects Mr. Housden recommended to be first taken up; and for these detailed Plans and Estimates were prepared.

5.—There is a Note on the project written in June 1885 by Mr. Gatherer, then Superintending Engineer for Rajputana; and later, in January 1886, Colonel Gordon Cumming, R.E., then Superintending Engineer for Rajputana, visited Karauli and inspected the sites of these projects, and wrote favourably of them and of the benefits which would arise from gradually carrying out Mr. Housden's proposals. He recommended that both the Gotra and Nindar projects should be sanctioned, Gotra being first taken up.

The works, however, were never carried out owing to the financial embarrassment of the State; and since that time the question seems to have dropped.

6.—Mr. Housden's reconnaissance of the State appears to have been thorough, and the results are so carefully recorded that any further preliminary investigation seems to be unnecessary. In any case the Council's proposal to engage one Overseer for the purpose would be of no practical use, unless he could be employed in marking out some of the best projects, after consultation with the Revenue authorities, and erecting permanent bench marks, so that any of the works approved could be taken up at any time.

7.—A letter—No. 367, dated 20th April 1903—was then addressed to the Political Agent, reminding the Karauli Durbar of Mr. Housden's investigation. The Consulting Engineer pointed out that owing to the completeness of Mr. Housden's reconnaissance and record of same, a further preliminary investigation appeared unnecessary, but suggested that as the papers were valuable they should be printed and placed on permanent record. He also asked that the best of the projects suggested by Mr. Housden might be marked out at site, and said: "If this could be arranged he would visit Karauli early next camping season, and inspect these projects in company with Mr. Manners-Smith, Superin-

tending Engineer,—whose service had been retained by Government to supervise the investigation work in those States without Engineers—and detailed plans and estimates of any projects approved by him, which the Karauli Durbar wish prepared, would then be worked out at Government expense, and be placed on record, to be carried out when the State is able and willing to take them up.”

8.—Letter No. 2365, dated 8th May 1903, from the Political Agent, Eastern States, to the Consulting Engineer, P. I. W., Rajputana.

“I have the honor to acknowledge the receipt of your letter No. 367-R, dated the 28th April 1903, regarding the investigation of Protective Irrigation Works in the Karauli State.

2. I have communicated the purport of your letter to the Karauli Durbar, but I would point out that they have hitherto declined to join in the Irrigation scheme of enquiry which is now proceeding, *vide* the correspondence that took place between this office and the Secretary P. W. D., Rajputana, in 1901.
3. With reference to para. 4 of your letter, it would be a very good thing to have the papers concerning Irrigation in Karauli collected and printed.”

9.—The Karauli State Council in their reply—letter No. 154 of 5th June 1903, to the Political Agent, Eastern States—stated that they were shortly going to engage the services of a qualified Overseer, and that they had in their service a draughtsman, who had worked under Mr. Housden, and who knew all the sites, and would point them out to the Overseer previous to Sir Swinton Jacob's visit.

They added, “The Council will be glad to point out the places for Sir Swinton Jacob's inspection, and in case they are approved of by him, Government may then work out the detailed plans and estimates.”

10.—On 24th August 1903, the Council wrote again to the Political Agent—letter No. 241 of 24th August 1903—saying they had not been able to secure the services of an experienced Overseer, but that they had applied to the Principal, Thomason College, Roorkee, and from the names submitted had now selected an Overseer who was expected to join his appointment early in September 1903, and he would very shortly begin the work of investigation of Irrigation Projects, a report of which would be submitted by the middle of October 1903, stating the points, should there be any, on which he considered the assistance or advice of the Consulting Engineer was necessary. This report has not yet been received.

11.—The above correspondence shows the efforts which have been made to help the Karauli State in the matter of investigation, and to enable the Durbar to take advantage of the information already recorded. This appears to be all we can do at present. Eighteen years have elapsed since Mr. Housden submitted his report. It is not known whether the Durbar were aware of it, or have been able to take any action

upon it, or if there has been any real desire to do so. The Consulting Engineer and the Superintending Engineer (Mr. Manners-Smith), if desired, are ready to visit any places or to give any advice; but to go over the same ground merely to repeat what is already on record, would be simply waste of time and money.

Mr. Housden's Report is now printed, so that it may be available at any time: whether he ever received the credit he deserved is not known, but it contains a deal of useful and interesting matter; and it is something gained to have rescued it from oblivion.

The Inspection Notes by Mr. Gatherer and by Col. Gordon Cumming, R.F., both Superintending Engineers for Rajputana, are also attached.

12.—The following points in Mr. Housden's Report appear to the Consulting Engineer deserving of attention:—

1. PARA 3, PAGE 7—"Owing partly to its geographical condition, partly to the difficulty of communication due to the broken nature of the ground on its borders, Karauli (in 1885) is singularly isolated and behind the times."
2. PAGE 8—"One effect of not conserving the water is that the nullahs and watercourses from the hills descend, cut the ground away, and extensive nullahs and ravines are formed."

"One effect of the lowering of the nullah beds is to completely drain the country of water and to lower the level of the sub-soil drainage to such a considerable extent as to entirely, in parts, prohibit even cultivation, the depths of the wells being in some cases over 100 ft."

"Owing to the tendency which the ravines thus formed have to increase, they yearly encroach on good culturable soil bordering on them, and so, year by year, gradually reduce the area of good land."

3. PAGE 10—"There is every sign to show that the country was once cultivated to a far greater extent than at present."

With good government and a liberal policy as regards Irrigation there is no reason why the State should not prosper.

4. PAGE 11—"There is a good deal of land capable of easy development, if cultivators can be, by easy terms and good government, induced to settle."
5. PAGE 11—"Owing to want of water and general apathy, the *Rabi* cultivation is small, large tracts lying idle during the winter months * * * the State land if fully developed * * * would give a revenue * * * of more than the present revenue of the entire State."

PAGE 12—"The figures given show what a large field there is to work on, and also show how necessary it is that a careful Revenue Survey of the entire State should be made, and the exact area of culturable land determined and property assessed."

6. PAGE 12—"The general character of the country (alluded to) is not favourable for development of revenue, the patches of cultivable land being few and small." This only shows the importance of making the most of them.
7. PAGE 12—"Attention should be confined to developing the present system of *Pokhers* (i.e., field in terraces formed by small bunds) in which rice is grown; and here and there constructing a tank sufficiently large to retain water all the year round. The object of these large tanks is to provide drinking water. At present during the summer months many of the hamlets are altogether deserted * * * Large tanks which retained water all the year would attract people and induce them to settle, and the regular cultivation of all the rice fields in the immediate neighbourhood be thus secured."
8. PAGE 13—81 sites for tanks were examined and reported on; a detailed report is given by Mr. Housden in Appendix A.
9. PAGE 14—"The estimates submitted, excepting for those projects which have been worked out in detail, though believed to be fairly accurate, are not to be implicitly depended upon.' Each project should, when finally taken up, be reconsidered afresh in all its bearings and proper designs and estimates drawn out."
10. PAGE 15—Regarding wells the Consulting Engineer suggests (1) that courses of dry stone or weep holes should be left below the water surface, so that when the well is being used and the water surface inside is lowered, water from the water-bearing strata outside may be admitted and not forced to enter from below. (2) A chain inserted in the masonry from above H. W. L. to the lowest level is useful sometimes in saving a life.
11. PAGE 15—"Wells, even when it is found necessary to make them 60 ft. deep, may be expected to pay." Mr. Housden advises the expenditure of a good portion of any money available on new wells as more suited to the limited resources at the disposal of the State, costing, as a rule, about Rs. 500 each on an average; they can be constructed as funds admit.
12. PAGE 16—"There are numbers of old wells in the State which have fallen in, or which simply want deepening, and can be put into good working order at costs varying from Rs. 50 to Rs. 200."

Mr. Housden adds: "I would recommend that all repairs to old wells, and the construction of new ones be carried out by the villagers themselves, under the joint supervision of the Tehsildars and the Public Works Overseer. The villagers are quite capable of sinking their own wells, and it is better that any small profit made on the sanctioned amount should go to them than into the pockets of an outsider."

13. PAGE 16—Mr. Housden's calculations seem to be carefully made and to be on the safe side. The actual cost from the rates taken will, as he himself states, probably be less than he has estimated.
14. PAGE 17, PARA. 9—"At present the areas of culturable land in the villages belonging to the State are but roughly known, and the boundaries between the Khalsa and Jagir villages of the vaguest. Again, the rates at which the same kind of land are assessed vary considerably in several parts of the State; in some cases the State suffers, in others the villagers are called upon to pay a revenue they cannot possibly meet, and the temptation to go over into the neighbouring States is irresistible."
15. Page 18, Para. 10, the most important part of Mr. Housden's Report—"A consideration of how the information thus collected can be best turned to the advantage of the State. There is little doubt that there is a large field for improvement."
 "The question is, how, with the limited funds at the disposal of the State, can any of the contemplated improvements best be carried out."

The Consulting Engineer invites special attention to Mr. Housden's remarks. He agrees with them entirely, and instead of repeating them here, begs a reference to the page indicated, and consideration of all the points noted.

13.—Mr. Gatherer, Superintending Engineer for Rajputana (in page 114) "considers Mr. Housden deserves great credit for the manner in which he has prepared the plans and estimates, and for the thorough investigations he appears to have made."

14.—Major Gordon Cumming, R.E., also Superintending Engineer for Rajputana (page 119) states his opinion, "that of all the Native States yet seen by me, Karauli offers the best scope for improvement by means of works judiciously planned and judiciously carried out; and that, if funds were only available, a few years work under an officer like Mr. Housden would effect a vast improvement in the welfare of this interesting territory. Excellent sites are available throughout for the formation of tanks on a large scale; land which is now comparatively useless for want of water, is to be had in abundance below those sites, and notwithstanding the scantiness of the population, it is more than probable that Irrigation Works on a large scale would attract labour from other less favoured localities."

He goes on to say: "Mr. Housden has travelled over most of the State, and has framed a programme, accompanied by approximate estimates of cost, for its improvement by means of useful Public Works. This he has embodied in an admirable memorandum, which should, I think, be printed for information and guidance.*"

I understand that shortness of funds is the chief and indeed only hindrance to the execution of useful and remunerative Public Works in Karauli; but as the State will soon be clear of debt, it is a question for

* This was not done apparently at the time, but has now been done.

consideration whether money should not be borrowed either now or then to inaugurate a scheme for the prosecution of works of the kind, for if these be carefully planned and carefully selected in the first instance, there is every probability of their paying a handsome revenue over and above interest charges."

He adds, "I hope that something of the kind will be done soon, in order that full employment may be found for Mr. Housden, whose interest in all that concerns the welfare of the State is undoubted. At present about half a lakh of rupees only are available for expenditure on Public Works year by year, and this is hardly sufficient to warrant the continued entertainment of an Executive Engineer and his staff of office and out-door Assistants.

By borrowing a couple of lakhs from Government and spreading its expenditure over two or three years, much useful work could be carried out, which if it did nothing else, would at least show whether new Irrigation works could or could not be carried out with advantage both to the State and to the people."

15.—The Consulting Engineer begs a perusal of the whole paragraph on pages 119 and 120. Eighteen years have elapsed and there appears to be very little to show for it. Had it been possible to retain Mr. Housden, or an equally capable officer, and to provide funds, it is impossible to say what good might not have been done. For eighteen years all the rain which has fallen on the State has passed away to waste. Some part at least might have been stored to benefit the land and people. It has been an annual loss to the State.

The Consulting Engineer feels it is impossible to give more information or better advice than is here recorded. What is really wanted is a lively interest in the subject on the part of the Durbar and all concerned. Until this is manifested, there is no hope of any real progress; something to prove that the interest shown by the Imperial Government in the welfare of the Native States is understood and appreciated.

In closing this Report the Consulting Engineer will only add his hope that something in the interests of the State will now be done, and his readiness to help the State, if desired, in any way in his power.

S. S. JACOB. COLONEL,

Consulting Engineer for Irrigation in Rajputana.

Juipur, April 1904.